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TANKS

by

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to
MY MOTHER

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INTRODUCTION

ALTHOUGH the invention of the internal combustion engine revolutionized the practice, if not the principles of war, few recognized this vital fact at the time and, unhappily, some do not realize it now. When it is remembered that it is more than thirty years since cars became so common a means of transport, the extraordinary length of time which it has taken to mechanize practical warfare becomes all too apparent. No nation has yet produced a wholly mechanized army. Even the Germans have only a comparatively small proportion of their numerous divisions which are armoured or motorized and we were, perhaps, somewhat astonished to see pictures of German guns entering Paris, drawn by horses. The time may come when all armies are completely armoured and motorized, although, perhaps fortunately, there is a limit to the manufacturing power of a modern industrialized nation.

This mechanization and armouring does not result in war being more destructive; nor, where it has been adopted equally by both combatants, does it imply heavier casualties. But it certainly makes war more expensive. Machine warfare means that a campaign might be decided by material rather than by men. It may be true, as reported from Flanders, Greece and Crete, that, man for man, the British soldier was superior to the German. But this superiority is purely theoretical if the British are relatively immobilized, underarmed or unarmoured, while the Germans have machines which give mobility, hitting power and protection.

And so the call is now for tanks and more tanks, as it was for aeroplanes after the evacuation of Dunkirk. It is an indictment of our conservatism that it should be necessary to make so urgent a demand twenty-six years after the first aeroplane went into battle and twenty-four years since tanks first proved their devastating power against unprotected infantry. But help to the factories is now better than recrimination if we can be assured that the lesson has been learned.

The plea for tanks will undoubtedly be answered by every

man concerned in their making, just as the need for aeroplanes has resulted in so vast a speeding up of Great Britain's aircraft factories. It is very necessary that these hundreds of thousands directly or indirectly engaged upon tanks, and the other army which has subscribed to tank funds as a token of their enthusiasm, should be able to appreciate the importance of all that has been achieved in the modern moving fortress.

This book contains a general account of tanks for that proverbial man-in-the-street, and for his wife to read at home in those few leisure hours which she can spare from the factory where she labours at 'work of national importance.'

This is not a technical book, much less is it a treatise on the still controversial subject of tank strategy or tactics, although these must inevitably enter to a degree into any account of tanks. The tank to-day can hardly be considered apart from the vast array of armoured and unarmoured vehicles which make up an armoured division, so that an account of these machines and a note as to their employment has been included. The British Army uses more than fifty different types of vehicle, not all of course, or even the majority, restricted to co-operation with tanks. But the general tendency to-day is to put everything on wheels or caterpillars. It is a natural corollary to the invention of the tank, although only a few, even among experts, seem to grasp that truth. The tank provided the means of forcing a war of movement rather than a war of positions; therefore it was inevitable that the rest of the army should move more quickly. The Germans knew this; long before the war their military literature made no secret of the methods they would employ, of their belief that the old plan of trenches and emplacement was dead.

Here is a quotation from a leading German strategist, written before the war. "A mass of tanks will rush forward with a supporting fire of gas and smoke shells. At the same time air forces will break through into the enemy's country, attacking airports, railway junctions, military cities, spraying large cities with explosive and incendiary bombs. This prelude to major warfare must be carried out with extreme speed. The attacker has the advantage. He knows what he wants. He will prepare his thrust carefully down to the smallest details and put it through with the utmost rapidity." It was the blue-print for the Polish campaign and later for the Battle of France. Both, apparently, took millions by surprise. And it was not even originated by the Germans.

The Russians had worked it out before, and before that British experts had put forward the theme. We were ready for it in 1919, but not in 1939. It was, in short, a principle known to everyone but the 'authorities.'

Yet this is not a book of what-might-have-beens and regrets. On the contrary, of one thing we can be sure. The tank was invented and developed in Britain. For a year the Germans scorned it; when they learned to treat it with respect, it was too late for the war of 1914-1918. They spent the years when we stripped ourselves of armaments, hoping that our example would be followed, in studying the tank, and eventually building armoured vehicles in enormous numbers. But there were brains that were not idle in Britain, even though they could not obtain the necessary support. Our ideas were developed on paper. Now they will be turned into reality; for our greatest detractors cannot deny that originality and progress in engineering design have long been the special perquisite of the English . . . and the Scots.

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Chapter One

THE IDEA OF THE TANK

IN essence the tank is a device for enabling an enemy to be attacked by men who are themselves protected from missiles and other weapons. The principle is as old as organized warfare, and if we regard the modern tank from this point of view it is the logical development by engineers of the chariot which had its origin at least 1,200 years B.C. All through the history of warfare on land, until the final triumph of explosives, we find armour and armoured vehicles being used. In fact, the siege engines of the Roman and medieval wars are more direct ancestors of the tank than the chariots which resembled a special form of cavalry and in which most of the armour was carried on the body of the fighting man rather than on the 'chassis' of the vehicle. Necessity is proverbially the mother of invention, and the need for the invention of siege engines was exactly the same as that which produced the tank; fortifications and a state of stalemate in a campaign which could only be broken up by the introduction of armoured weapons. The Western Front in 1914 consisted of elaborate fortifications, not walls and towers as in pre-explosive times. but a labyrinth of trenches which was, in truth, a fort stretching from the North Sea to Switzerland, almost impossible to break with the weapons then available.

The early fortified cities with their walls and towers presented the same problem. Arrows, swords and spears could not reduce fortifications. Catapults and slings could not be brought near enough without devastating casualties resulting from the enemy's higher position from which he could pour down fire. Gates could be burst open with battering-rams, and walls reduced to rubble with picks or heavy missiles, if only the soldiers could be protected while they worked. The first armoured vehicles were produced for this purpose and took, to our eyes, many strange and fantastic shapes. The armour was not of steel or even iron, which, apart from the weight, could not then be produced in large plates. Hides, wooden boards and basketwork were among the materials used to armour these forerunners of the tank.

One of the chief siege engines of Roman times was a wooden tower designed to give besiegers a superior position over the garrison on their walls. These towers were built on wheels to a height of seventy feet or more, according to height of the fortifications; the top storey being given to archers, the second storey to artillery, slings or catapults, and the 'ground floor' to the ram. Here we have the machine-gun, six-pounder, and the crushing power of the modern tank. The armour was a roof of wooden beams covered with clay, bricks, or hide and screens of basketwork, while hides or plaited rope hung down the front. To reach these towers in comparative safety and to provide cover for men working against the walls, light armoured vehicles on wheels were developed. Propulsion, of course, was by man power in all cases, so that they had to be reasonably light. The usual armour was of closely woven hurdles, sufficient to hold up arrows, stones and the many unpleasant things which garrisons dropped upon an attacker. Fire was a danger, as it is now; many of these armoured vehicles carried their own extinguishers—reservoirs of water. Another vehicle was the 'Tortoise,' the name aptly describes its shape; it was low and gave protection from above while the 'crew' picked the fortifications to pieces.

These fighting vehicles were often improvised on the spot. One envies the 'tank committee' which could sit within sight of the enemy, decide on a design and have it built within a matter of days; knowing that if it failed, an improved design could be devised for putting into action. Any materials handy might be used. When the Romans besieged Marseilles, Cæsar records that the armour for an elaborate tower was made by plaiting together ships' cables. It is interesting to note that not a single life was lost on this tower; a remarkable early instance of the life-saving quality of the armoured vehicle.

Gunpowder completely changed fortification and siegecraft; earth became the chief protective material for the besieged. Hides, osiers and similar material were quite useless as protection against bullets, so that siege engines disappeared with the coming of heavy artillery to batter the defences from a distance. Explosives, temporarily, sealed the doom of armour whether carried on a vehicle or on the body, where its weight proved a grave disadvantage. The real reason for this condition is often misunderstood and it is rather important in connection with tanks. It was not that the armourer could not produce plates thick enough to resist the impact of bullets. He could make armour to resist the

impact of cannon shot, and eventually did so for warships. The armoured knight disappeared because the weight of his armour, if it were to give protection against bullets, would have been so great as to render him completely immobile. Even before the coming of gunpowder armour had become so elaborate and heavy that a mounted knight could hardly move at a trot; no horse carrying a well-set-up warrior and his heavy equipment could have galloped in the manner so gaily depicted by artists. More probably, the knights moved forward at a pace little greater than the footsoldiers.

In the British Museum is a drawing of an armoured fighting vehicle made in 1482 by that indefatigable inventor and universal genius, Leonardo da Vinci. The method of propulsion was crank-handles attached to horizontal trundle wheels. Whether he ever built any of these machines seems uncertain, but his notes say that the carriage can advance into the midst of the enemy; to be followed by infantry in comparative safety, a remarkable anticipation of the actual use of the tank made four and a half centuries later. Major Clough Williams-Ellis, M.C., and A. Williams-Ellis, in their book *The Tank Corps*, record that there were designs for a tank in the Crimea War, but that they were abandoned as barbarous. It is interesting to record that our ideas for poison gas, or, rather, smoke clouds, in the same way, were mostly abandoned for the same reason. Major E. W. Sheppard records that at Ravenna in 1512, thirty cars, each carrying a group of arquebuses, designed by Pedro Navarro, were employed by the army of the Holy League. These vehicles had scythes on the wheels in the fashion of an ancient chariot, but they seem to have been used for defence as miniature forts rather than for offence in support of infantry.

Knights in armour disappeared for one main reason alone. The weight-carrying capacity of a man is limited, even 300 pounds per man does not allow enough power for weight ratio to render a bullet-proof man mobile. The idea of having a machine to take the weight must have been in the minds of many inventors, but the motive power was lacking, for horses have a very high weight per horse-power ratio. The steam engine did not solve the problem, for this, even in its more efficient form to-day, has a comparatively high-weight horse-power ratio. Moreover, the steam engine, with its fuel and water, was bulky. All this bulk had to be protected by further armour so that no increase in the size of the engine offered any prospect of a practicable armoured

car, although steam fighting vehicles were actually tested in the Great War.

The problem was different at sea and during the latter half of the nineteenth century armour became more and more efficient. This was, much later, to prove of importance to the armoured vehicle. A modern tank, if it was restricted to the armour of fifty years ago, would be so heavy as to be immobile. But steel was improved until a sheet little more than one-quarter of an inch thick was capable of resisting a high-velocity small-calibre bullet. If modern bullet-resisting steel had been available four centuries ago, the armoured knight would not, perhaps, have suffered eclipse, since the bullets of those days had less penetrative power. It is worthy of note, perhaps, that the development of armour is by no means complete and that we may yet see entirely new materials used for this purpose. Plastics, many times lighter than steel, offer astonishing possibilities in this direction.

The tank, like the battleship and the aeroplane, is not a single invention, but a combination of a number of designs of which two were of primary importance. These were the caterpillar method of traction and the internal combusion engine. The invention of the tank was little more than the bringing together of these two devices for the specific purpose of providing mobility and protection for men using small arms. Other properties of the tank, such as demolishing obstacles, or flattening barbed wire; were incidental to its great weight. Without the caterpillar principle there was no tank, but simply an armoured car; these, of course, were built and used long before the beginning of the Great War. Without the internal combustion engine, it would be difficult to obtain the weight-power ratio required to carry the necessary armour at any appreciable speed.

The tank, therefore, 'waited' on these inventions; it could not have been built in any practicable form much before 1910. The first internal combustion engines were very heavy for the power produced, the useful ratio necessary for a tank was not reached until about 1905. A caterpillar method of traction is said to have been originally patented by R. L. Edgeworth as early as 1770, and a steam caterpillar tractor was built during 1888 in the United States, but it was not until the first decade of the twentieth century that the principle was fully developed. This was intimately connected with the reduction in weight of the internal combustion engine, for the weight of the early steam tractors was such as to make them almost useless for practical purposes. The develop-

ment that took place shortly before the Great War is illustrated by production figures in the U.S.A.: 4,500 in 1910 and 11,400 in 1912. The United States called these vehicles crawler tractors, but the apparent similarity to the progress of a caterpillar led to this word being used in Britain and eventually to it becoming universal.

The caterpillar method developed for farm vehicles was taken over almost as it stood for the first tanks. The caterpillar principle is really that of the vehicle laying its own special road or track in front of its path. It is just as if a mountain locomotive laid its racked rails in front as it made progress. The tractor uses the same track over and over again by the simple expedient of returning it in a circle to be 'laid' afresh. The great advantage conferred by the caterpillar principle is that the weight, instead of being carried on four small points where the wheels rest upon the ground, is distributed along most of the length of the vehicles which in consequence does not sink into the ground to the same extent.

In the first practicable examples, the track consisted of a number of plates linked together, the outside having transverse bars to give a grip of the ground and the inside being left smooth to run against the 'idler' wheels. Power was carried to the track through a differential gear and two chain wheels. To steer the tractor, the driver had brakes which could be applied separately to either track, by action on the shaft of the chain wheel. By slowing or stopping one track, the vehicle was forced to turn. It will be seen that this successful method of transmission and steering was almost exactly that used in the first experimental tanks. Earlier examples had separate steering bogies projecting from the main chassis, and a number of electrical or hydraulic devices were tested to secure the best form of differential control.

The 'raw materials,' as it were, of the tank, existed, therefore, some years before the opening of the Great War. It only remained for someone to put them together, enclose them in a steel box and equip it with armament. But the need for the tank had not arisen. The opinion of British experts and, apparently, of experts of all other armies, was that the next war would be one of movement; it is certain that few visualized what amounted to a war of siegecraft. That the tank could be the vital weapon in any war of movement did not occur to the majority until many years after the end of the Great War. No doubt the argument was put forward that, in a war of movement, cavalry were faster and less liable to breakdown.

Once the tank had made its successful début in battle, any number of inventors for it were found, apart from those officially connected with its development. There is a story that after the Great War the model of a tank built by an English plumber was found at the War Office, covered in dust, and labelled 'The man's mad.' It is probably apochryphal, but, as later chapters will show, the obstacles placed in the way of progress of the tank in some quarters was such that the tale deserves to be true. Long after the war it was revealed that an Australian inventor, L. E. Mole, had submitted a design for a track-driven fighting vehicle to the War Office in 1912. F. Mitchell, in *Tank Warfare*, says: 'In its pivoted ends and flexible chain tracks for steering a curved course it seems to have been superior to the tank.' However that may have been, the fact seems to be that the design was not seriously considered and it played no part in the actual development of the tank during 1914-1918. Ironically enough, for it was the tank that was to play a leading part in crushing 'the invincible army,' it was in Germany that the first public demonstration of a climbing fighting vehicle was given. This was in 1913, the inventor being one Herr Goebel. It is not clear whether it was a caterpillar machine, but it seems to have been fairly successful in overcoming moderate obstacles. At a demonstration in Berlin early in 1914 the vehicle gave out after moving only a few yards and was 'laughed out of court.' It does not seem to have been taken seriously by the German military experts and it is by no means certain, even if they had been less conservative, that they could have developed it into a vehicle as efficient as that which caused panic among their infantry only two years later. After seeing it in action, the Germans did not take the tank very seriously.

There are other major and minor claims to have invented the tank, and no doubt many people had at one time or another interested themselves in the idea. Given the proposition, to construct an armoured vehicle that would climb obstacles, any one of thousands of engineers in 1914 could have produced a design in a comparatively short time. The tank was not so much invented as given a very protracted and painful birth. But for the confidence and insistence of Mr. Winston Churchill, together with a handful of enthusiasts who believed the infant would prove a prodigy, it would have been strangled on a number of occasions before it had had a chance to see the light of day. The story of the prolonged birth-pangs is told in the following pages.

No account of the idea of the tank before the Great War would

be complete without mention of the tank's appearance in fiction. No author can claim to have 'invented' the tank, although a number foreshadowed it and even described its tactical uses quite prophetically. 'Science fiction,' as we call it to-day, describes many inventions which are later made, but the author has this great advantage over the engineer that he is not troubled by 'technical hitches,' and he can quite reasonably postulate methods of propulsion which have not yet been invented. Authors who described landships, land ironclads, or whatever they may have called them, no more invented the tank than Jules Verne invented the submarine. That is not to say that they did no valuable work apart from their primary purpose of entertaining their public. Science fiction serves the useful purpose of stimulating the imagination of the public, of making them accustomed to novel ideas before any plans can have been turned into practical form. It may be that if the reading of science fiction were compulsory amongst those responsible for the development of fighting forces, new weapons would not always be so strongly resisted by so-called 'competent' authority.

Most famous of the fictional forecasts of mobile armoured warfare is a short story by Mr. H. G. Wells, first published in December, 1903. In *The Land Ironclads,* Mr. Wells illustrates the thesis that an army of 'townsmen' using the latest ideas of science and engineering would easily defeat a much larger professional army trained in the old ideas. Manhood versus Machinery is the headline that occurs to the war correspondent through whose eyes the battle is chiefly seen. The setting foreshadows the Somme; elaborate trenches, with both sides 'sitting tight' and apparently unable to storm the fortifications of the other without enormous loss to themselves. The 'professional' army is confident that they will mow down the 'amateurs' when they attack, as indeed they did in the Battle of the Somme. But suddenly, as was to happen at the end of that battle, strange iron monsters creep across from the opposing trenches. Bullets bounce off them like raindrops, and on they come, climbing obstacles and straddling trenches, to enfilade the infantry in them by firing through slits in their 'tank' armour. These ironclads were eighty to a hundred feet long, with 'thick stumpy feet between knobs and buttons in shape,' steered and controlled by an officer using a conning-tower in the centre and manned by riflemen who used a remarkable sight based on the principle of the camera obscura. 'They were essentially long, narrow and very strong steel frameworks carrying the engines,

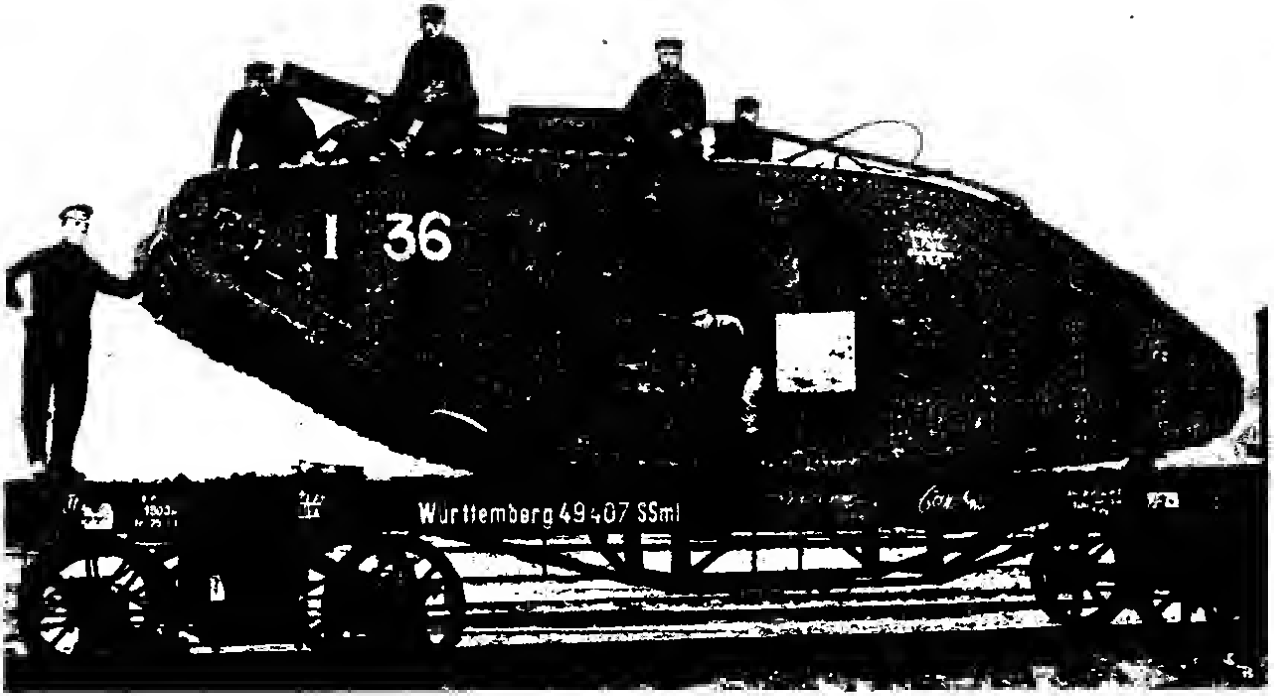
and borne upon eight pairs of big pedrail wheels each about ten feet in diameter.' The motive power appears to have been petrol, for Mr. Wells describes the powerful smell of petrol and oil inside the land ironclad, although in another place he speaks of 'squirts of steam' issuing from them.

In many respects the story in atmosphere, details and tactics used, was an almost uncanny forecast of events which were to take place thirteen years later; the destruction of artillery attempting to fire on the ironclads, for example, by the manœuvre of outflanking the guns and killing the gunners before they could turn their weapon, is forecast in detail. It would be interesting to know how many of the first pioneers of the tanks had read Mr. Wells's story, not because it suggests constructional details, he takes the author's right to skate over technical difficulties, but because of the remarkable way in which, granted a mobile armoured fighting vehicle, he shows the tactics that should be used. 'Mankind versus Ironmongery' the journalist decides to call his story in the end; the title is not inapplicable to the warfare we have seen in the last few years.

Not a few authors of 'penny dreadfuls' forecast the tank, although with none of the carefully thought-out tactical detail of H. G. Wells. For a halfpenny, children now men could read the astonishing feats performed by the armoured vehicle called 'The Beetle,' which could cross trenches and knock down houses. This tank had the ability to burrow underground and fantastic as this may have seemed to the readers at the time, long before the first real tanks, it is now within the realms of possibility.

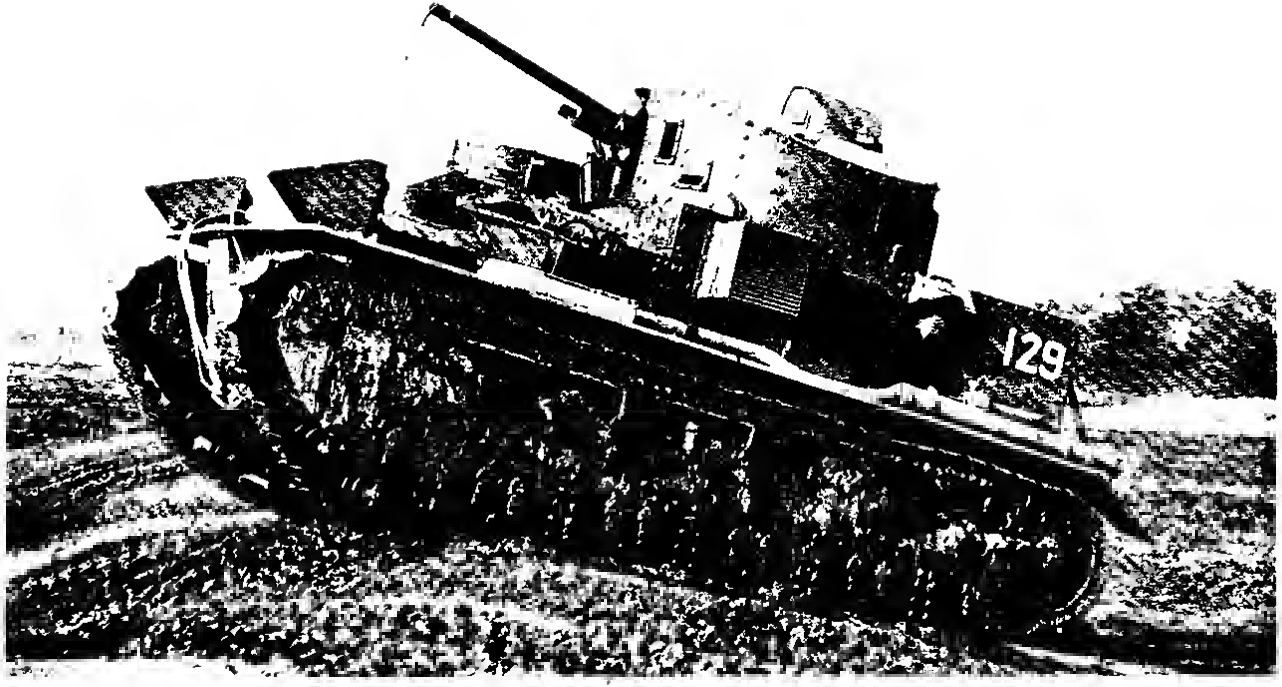
Lu Senarens, the great American writer of 'penny dreadfuls,' or 'dime novels' as they called them in the U.S.A. in the last century, let his hero perform some remarkable feats in the 'Magnet,' an armoured vehicle which was steam-propelled and resembled the turret of an ironclad mounted on a goods truck. The tank was one of the few inventions not forecast by Jules Verne, although he did describe a remarkable amphibian vehicle which in some ways resembled it in form. Jules Verne was always up against the difficulty of propulsion and he solved it by propounding the most astonishing electrical devices. Perhaps they too will be true one day, when electricity is better understood.

No doubt there were many other fictional forecasts of vehicles not unlike those which were eventually to break up trench warfare on the Western Front. They are not really surprising, for, to the imaginative man, it was an obvious development, a mere applica-



BRITISH TANK, 1914-18

This tank, mounted on a railway truck, visited practically every town in Central Europe



A TYPICAL BRITISH TANK OF THE HEAVIER TYPE

tion of the wealth of scientific discovery and invention of the nineteenth century to the vehicles which, as has been described, had been used since the beginning of war. The boy of 1914 accepted the idea of the tank quite naturally and, no doubt, was a little surprised at the astonishment of his father when it appeared that such vehicles had actually been built. Would it be obvious to point the moral of this to-day?

Probably not. For the Admiralty once deprecated the use of steam instead of sails; the War Office following their example by pointing out the uselessness of radio for industrial purposes and the worthless nature of flying from the military point of view. Nor are these occurrences out of date. The principle of the very successful magnetic mine was known to the authorities long before the war of 1939.

Chapter Two

THE BIRTH OF 'BIG WILLIE'

We have seen that, by the outbreak of war in August 1914, the idea of the tank was in a number of minds and that the basic inventions necessary to make an armoured vehicle capable of carrying gunners safely over obstacles had been made. Large internal combustion engines with a power weight ratio of about 11 pounds per horse-power could easily be made. The caterpillar method of traction had advanced to a reasonable degree of efficiency. Yet it was not until twenty-five months after the outbreak of war that the first tanks went into action. The story of what happened during those twenty-five months is involved. Many different men in the Army, Navy, and even the Royal Naval Air Service, as well as civilians, contributed to the ultimate success of the new tank. There were endless committees, orders and counter-orders. The flood of post-war memoirs told an amazing story, not greatly to the credit of some and greatly to the credit of a few, including Mr. Winston Churchill, General E. D. Swinton, Captain Tulloch, Sir William Tritton, General H. J. Elles, Mr. Tennyson-d'Eyncourt, General F. J. C. Fuller and General Martel, to mention only some whose names will always be remembered for their faith in the new weapon.

Let us try and find our way through the complicated series of events which led to the first use, or rather misuse, of tanks on the

Western Front in 1916; events destined to change the nature of warfare for at least three decades. Mr. Winston Churchill in his *World Crisis* rightly points out that some of the confusion resulting from attempts to allocate honour for the invention of tanks was based upon a lack of appreciation of the two principles involved. There was (*a*) the responsibility for initiating and sustaining the action which led to the tanks being produced, and (*b*) the credit for solving the extremely difficult problems connected with designs as apart from main principles. These services were entirely separate. There never was a moment when it was possible to say that a tank had been 'invented.' There never was a person about whom it could be said "this man invented the tank."

In the early months of the Great War, Mr. Winston Churchill and General, then Colonel, Swinton, had both conceived of the need for armoured fighting vehicles like the tank, although neither knew of the work of the other. Colonel Swinton had gone to France with the British Expeditionary Force as official 'Eye-witness.' They say the onlooker sees most of the game, and just as soon as the system of trenches began to be dug by both sides, and the thousands of miles of barbed wire to be stretched across acres of ground between them, Colonel Swinton realized that some device capable of crossing trenches or passing through barbed wire would be necessary if the virtual stalemate was to be broken up, other than by the most ghastly blood baths. For the first time in warfare the machine-gun had become 'queen of the battlefield,' enabling half a dozen determined men to take fearful toll of attacking infantry and rendering cavalry virtually obsolete.

Mr. Churchill was then concerned with the Navy and not the Army and, even more paradoxically, it was the Royal Naval Air Service that led to the genesis of the tank in his mind. 'The armoured car was the child of the air; and the tank its grandchild.' Mr. Churchill was responsible, among many other things, for the defence of R.N.A.S. aerodromes near Dunkirk. Armoured cars were sent to their defence, but very soon both sides, in attempting to get round the flank of its enemy, reached the coast of the North Sea. The armoured cars could not go over the trenches. Mr. Churchill's keen brain immediately perceived that this manœuvre was essential.

The story now switches to Sir William Tritton, a specialist in agricultural machinery. He had been making agricultural tractors for South America when war broke out and prevented their ship-

ment. At this time Admiral Bacon, General Manager of the Coventry Ordnance Works, produced some remarkable 15-inch howitzers, and a few days after the outbreak of war told Mr. Churchill about this work. Mr. Churchill was impressed, and Lord Kitchener gave an order. But the important point is that drawings produced by Admiral Bacon to Mr. Churchill in October, 1914, showed the guns being drawn by caterpillar tractors; these were designed and supplied by Sir William Tritton. Mr. Churchill, with the problem of crossing trenches in mind, asked whether Admiral Bacon could design a vehicle capable of performing this feat. Sir William Tritton built, and in November demonstrated, a caterpillar which crossed trenches by laying down a bridge which it carried itself; a foretaste of the unditching beams and fascines which years afterwards were to be used by tanks. Mr. Churchill placed an order for thirty machines in February, 1915, but three months later when the first was completed, the order was cancelled by the War Office.

Mr. Churchill was by this time interested in the tank from another point of view. He had heard of Colonel Swinton's work, and in a letter to the Prime Minister on January 5th, 1915, a copy of which was sent to Lord Kitchener, he emphasized the importance of armoured vehicles. Later in the month he was initiating all sorts of experiments, including smashing trenches with steam-roller devices. He records that a dinner with officers from armoured-car squadrons in February, 1915, sent him home determined to carry out in some way the idea he had had in mind all these months, and he directed Major Hetherington, of the R.N.A.S., to submit his plans. These were discussed with Mr. Tennyson d'Eyncourt, Chief Constructor of the Navy, and others in Mr. Churchill's bedroom—he was then ill. Within a few days there was formed the Landships Committee of the Admiralty, the Chief Constructor being made the President.

The type of vehicle they discussed was that of a large platform mounted on huge wheels carrying three 4-inch gun turrets and powered by an 800-h.p. motor. The wheels, 40 feet in diameter, were designed to surmount obstacles; it will be seen that the tank eventually used the same principle but in a different way. It was calculated that this machine would cross trenches with good banks at least 20 feet wide and have a speed of 8 m.p.h. The moral effect of such a machine on the unfortunate German infantry might well have been even greater than that of the tank, but the practical Chief Constructor quickly showed that a vehicle

of these dimensions would weight 1,000 tons and present a considerable target to enemy artillery. It would, in addition, have required wheels of considerable width, and firm going if its great weight was not to force it into the ground.

A month later the committee had developed designs for two much smaller fighting vehicles. One had wheels and the other caterpillars. Mr. Churchill boldly ordered six samples of the wheeled, and twelve of the caterpillar vehicles, personally making himself responsible for the cost, about £70,000. 'Boldly,' because if these vehicles had come to nothing, he might have had difficulty in justifying the way in which he had cut 'red tape' in order to hasten the work. Mr. Churchill's contribution to tanks was insistence, boldness, determination to have these fighting vehicles in some practical form, and willingness to experiment. He did not invent the tank, he has never made claims to mechanical knowledge, but it is very probable that without him engineers would have had no chance whatsoever to solve the problem. He had the executive authority they lacked, he was not afraid to use it, and he had foresight.

The eighteen experimental machines were never constructed. Mr. Churchill left the Admiralty in May, 1915, and his followers looked with disfavour on the expenditure of the money he had authorized. But Mr. Churchill, as a member of the War Committee of the Cabinet, was able to prevent the whole experiment being thrown over. One vehicle was built, and this eventually became the 'mother' of all the tanks.

We must now go back to consider the work of Colonel Swinton who had been fighting his own battle with the authorities. Colonel Swinton and Captain Tulloch both independently conceived the idea of an armoured vehicle, a 'mobile machine-gun destroyer,' to overcome the defences springing up on the Western Front. By November, 1914, they were working together and a number of memoranda were made. One of them was submitted by Sir Maurice Hankey to the Committee of Imperial Defence. It did not arouse much enthusiasm. All sorts of objections concerned with the manufacture were made; materials were limited and could not be spared for such speculation. It was this memorandum that led to Mr. Churchill's letter of 5th January, and later Colonel Swinton was asked to call at the War Office. Nothing came of the interview. But Colonel Swinton persisted. His original idea had been based on the Holt tractor, about which he had heard from an American friend, and his first experimental machine was really

an armoured Holt tractor. This was demonstrated in February, 1915. The obstacle tests were too stiff for it; the War Office at the same time were turning down another vehicle because it could not pass through three feet of water, a feat no tank in the Great War managed to perform. But it did demonstrate the astonishing way in which barbed wire entanglements were levelled by a heavy vehicle. This 'Land cruiser' was fitted with wire-cutters, as were some of the early vehicles considered by Mr. Churchill. The wire-cutters proved quite unnecessary. The machine itself was capable of ripping up and levelling any barbed wire defence. Those whose minds were not completely closed to anything new saw a ray of hope. Here was a means of cutting a way through those terrible entanglements that held up attacking infantry while machine-guns mowed them down, an alternative to the expensive and not always successful preliminary bombardments.

Thus the War Office and the Admiralty had been working independently and it was not until June, 1915, apparently, that they heard of each other's work. A very usual state of affairs which is much encouraged by jealousy. They first 'met' in this connection at a demonstration at Wormwood Scrubs, the spectators included many of the great war-leaders: Mr. Lloyd George, Lord Kitchener, Mr. Balfour and others. A joint committee was formed, the first of a number, and the stormiest period of the tank's history began which showed not only the astonishing prejudices of what is often called 'the official mind' (not all officials have it), but the great complexity of modern warfare. Separate bodies all had their say on different aspects of the same matter. There was the supply of materials, manufacture, designs, and the tactical use of the weapons when made. In *The Tank Corps,* by Major A. Clough Williams-Ellis and A. Williams-Ellis, the chief actors in the drama are summarized as follows:

The War Office: (1) In its capacity as Ordnance, and (2) in its capacity as General Staff. Later (3) as the Tank Department, War Office.

G.H.Q.: (1) In its main capacity, and as (2) the Experiments Committee. Later the Heavy Brigade Machine Gun Corps. Finally, the Tank Corps.

The Admiralty: (1) In its capacity as the Land Ship Committee, and (2) as Squadron 20 of the R.N.A.S.

The Ministry of Munitions: (1) In its capacity as the Trench Warfare Department; (2) in its capacity as the Inventions

Department; (3) later as the Mechanical Warfare Supply Department (really another Tank Committee); (4) later still, as the Tank Supply Department.

The successive Main Tank Committees: (1) The Joint Naval and Military Committee, (2) the Tank Supply Committee, afterwards called the Advisory Committee of the Tank Supply Department, and divided into a main committee and a sub-committee. Later (3) after a gap, the First Tank Committee; (4) the Second reconstructed Tank Committee.

Grand Chorus of Directors General, Interdepartmental Conferences, Manufacturers and Workshop Personnel.[1]

With the possibilities offered by this remarkable cast, the reader will readily appreciate the complications which occurred. Most of them seem, to-day, exceedingly tedious, and it is not proposed to trace them in any detail. The mere setting out of the bodies involved, quite apart from their individual prejudices, ignorances, enthusiasms and idiosyncrasies, while we are engaged in another war, is, perhaps, not without interest in showing the difficulties that may arise in getting a new type of warfare accepted, especially where it is 'amphibian' as was the tank.

To return to the middle of 1915, one of the first difficulties arose over man-power for the tanks. The Army could not or would not spare a single man. The Joint Committee hit on the brilliant idea of appealing for volunteers from the Suffragettes, who had certainly shown courage in pre-war days. Sixty odd women immediately volunteered, but, happily before they were seriously considered, the Admiralty were persuaded to give the committee the expanded 20th Squadron of the Armoured Car Reserve and 600 men became available.

One of the problems that arose was that of designing a caterpillar vehicle with the climbing and trench-crossing capacity demanded by G.H.Q.; they laid down their requirements in September, 1915, and yet not of the vast dimensions of Major Hetherington's machine which has been described. The problem was brilliantly solved by Sir William Tritton and Lieut. Wilson by giving the landship, it was not yet called a tank, an upturned 'snout.' Instead of using the whole immense circle, a wheel of not less than 15 feet diameter was required to climb the Flanders trenches, they used a segment of the circle, the rising front of

[1] From *The Tank Corps*, by Major Clough Williams-Ellis, M.C., and A. Williams-Ellis (1919).

the tank being, in fact, the right-hand bottom 'climbing' corner of a huge circle.

Another difficulty arose over the production of a suitable track. Their first real tank, 'Little Willie,' failed because it would not keep on its tracks. They tried many alternatives, including a track of Balata belting. Then, on 22nd September, 1915, they found a solution for the problem. The telegram they sent Lieut. —later Sir Albert—Stern, Secretary of the Joint Committee, admirably combined secrecy with a touch of humour:

> 'Balata died on test bench yesterday morning. New arrival by Tritton out of Pressed Plate. Light in weight but very strong. All doing well, thank you, Proud Parents.'

This tank was to become 'Big Willie,' the prototype of all the tanks. It was originally called H.M. Landship Centipede. The name tank was not born until the vehicles first began to be made in quantity.

The state of affairs in connection with tanks can best be judged from the fact that Major Clough Williams-Ellis records that on Christmas Day, 1915, Sir Douglas Haig, reading Mr. Winston Churchill's paper, 'Variants of the Offensive,' pinned a little note to it with the question: 'Is anything known about the Caterpillar referred to in par. 4, page 3?' It was an astonishing thing that the British C.O.C. knew nothing of caterpillars at that stage, but it is an ill-wind. . . . Haig sent a young officer to England to find out about these new devices. The officer was Lieut.-Colonel Hugh Élles, who was afterwards to be the brilliant commander of the Tank Corps.

This paper of Mr. Winston Churchill's, 'Variants of the Offensive,' was written on 3rd December. Mr. Churchill had resigned from the Cabinet in November and joined the army in France. He realized that here was an opportunity to give his ideas where they were needed and where they would be most useful. 'I conceived myself to be the bearer to them of a good gift. This gift was the conception of a battle and of victory . . .' to use his own words. One of the 'Variants' was the use of caterpillar vehicles to cut the enemy's wire and to secure general domination of his lines. The paper shows that Mr. Churchill over-estimated the vulnerability of tanks. He thought they would have to be used almost wholly at night, although it is true that when later on attacks were launched after the half-light of dawn had gone, casualties were heavier. But he brilliantly described the tactics

they should use—and the tactics they did eventually use after bitter experience and the loss of many hundreds of men and vehicles. He showed that the cutting of the wire by artillery, then accepted by both sides as the only method, was doomed to failure against defence in depth because it gave the enemy many hours' warning and enabled him to bring up reinforcements. He concluded: 'They would, as they advanced, carry the infantry attack along with them and serve as movable *points d'appui*, guiding and defining the attack.' These, in fact, were the tactics first used at the Battle of Cambrai in 1917 with success; but before this tanks had gone through a series of comparative failures because the generals, with the actual vehicles in their hands, had not the fine imagination of Mr. Churchill before one single vehicle had been constructed.

The 'Mother' tank was completed on 3rd December, 1915, by a curious coincidence on the very day Mr. Churchill was describing how the new weapon should be used, although the designer knew nothing of Mr. Churchill's paper and Mr. Churchill, no doubt, knew nothing of the progress of 'Mother.' The tank was built at the works of Messrs. Forster & Co., Lincoln, who were specialists in agricultural machinery. It was tested secretly by being driven about the countryside at night, given firing trials, and shown to be satisfactory. It remained to demonstrate it before the men who really mattered, that is to say the men who could decide upon the building of hundreds of tanks. The demonstration was arranged for 2nd February, 1916, a historic date in tank history. The venue was Hatfield Park, the audience including Mr. Lloyd George and Lord Kitchener. This demonstration was a success and the huge vehicle performed everything expected of it by the most enthusiastic. Only Lord Kitchener, who had come with one officer, was unimpressed. "It's a very pretty mechanical toy," he remarked, "but I don't think it can be completed in time." Fortunately, other opinions prevailed. Six days later King George V was given a demonstration. A Tank Supply Committee with greater powers took the place of the Joint Committee, Lieutenant Stern becoming President. An order for one hundred tanks was given, later increased to one hundred and fifty. They were to be built in six months. The possibilities of the new weapon were such that everyone began to issue orders for secrecy; surprise was to be the big feature of the tanks on the Western Front. The secret was well kept, perhaps one of the best kept of all secrets when it is remembered that thousands were con-

cerned. Unfortunately, most of the value of the secrecy was thrown away in the method in which the tanks were used. The Germans, typically, were given two years' notice that tanks were a decisive weapon.

The keeping of the secret is a little story by itself. The official idea of the best way to keep a secret was to surround a factory with harbed wire, challenge everyone, circulate documents marked 'very secret,' and mutter in whispers. Sir William Tritton had other ideas. He knew all these precautions were the surest way to get things talked about by everyone. He, therefore, went to some trouble to avoid giving the impression that the strange designs concerned anything of great importance, and when the idea got around that it was 'some crazy idea of the governor's,' he did not discourage it at all. Of course, when the first completed tank was driven outside the factory, precautions had to be taken. On its journey to Hatfield Park by night it was completely enveloped in tarpaulins, even then roads nearing the grounds were closed, sentries posted and people with houses in the neighbourhood made to draw their blinds.

Later, when large-scale manufacturing began, it was impossible to pretend that it was 'just a crazy idea of the governor's.' But amazing rumours began to go round and advantage was taken of their popularity. With memories of the 'Russians with snow on their boots' story, one of the tanks was labelled 'Petrograd,' and the idea leaked out that this was some absurd scheme of the Russians, who, of course, were wild enough to try anything. The shape of the great steel bodies suggested the idea of labelling them 'Water carriers'; it was assumed for Mesopotamia, and from this came the name 'Tank,' which was gladly accepted officially as being completely unassociated with the real thing. If the Germans heard about it, it seemed likely to lead them to suppose that Britain's Middle East army was thirsty rather than that its Western force was building an unpleasant surprise. The name seems to have been first widely applied when the tanks were shipped to France, and Press reports after their first use do not mention the word tank. Sir Douglas Haig called them 'our heavy armoured cars.'

The same secrecy was maintained with the recruitment and training of the crews. Volunteers were sought amongst officers with engineering experience for what they understood was an experimental unit of an Armoured Car section of the Motor Machine Gun Corps. At the interviews at which they were

selected the candidates were given no hint of the nature of their work. They were put under the command of Colonel Swinton, who, at last, was to see his dream come true and whose name will always be associated with the greatest revolution in warfare since the invention of gunpowder. The men started training in March, but, of course, there were no tanks for them to train with. They learned to use the Hotchkiss machine-gun and six-pounders with which the tanks were to be equipped, were given courses in map reading, revolver shooting and so on, but even after three months the men themselves had no definite information about the job that lay before them. There was a general idea that it was connected with some new form of fighting vehicle, but the secret was so well kept that even when they moved to Elvedon, near Thetford, which was to be their tank training ground, the men knew nothing of tanks, even if they had heard this undescriptive name. Similar open secrecy was adopted in the naming of the first Queen Bee, when the late Sir David Henderson, then Director-General of military aeronautics, said: "We have got to think of some d——d lie. . . . Call it the Aerial Target."

At Elvedon, the volunteers found themselves the centre of mysteries worthy of a thriller. Twenty-five square miles had been absolutely cleared of inhabitants, roads running across this land had been closed, six lines of sentries guarded the approaches, and, just in case they missed anything, there were also cavalry patrols. It was as hard to get out as to get in to this area. The curious public who approached soon scurried away when they saw notices stating that it was a very dangerous explosives area, and the pilot of an aeroplane who was curious about the mystery, found himself heavily fired upon. At last some of the machines arrived from Lincoln and the mystery was solved, as far as the men in training were concerned. On the whole, they were delighted and soon became completely absorbed in the intricacies of the machinery. From this first day the men gave themselves up to the machines, to mastering their mechanical weaknesses, which were numerous, to admiring their offensive power, which was great. That has been the spirit of tank men ever since.

What were they like these first tanks that lumbered over the trench systems of Elvedon, exactly modelled on a section of the lines on the Western Front? Very different from the tanks of to-day. The younger generation, if they met one in the road, might, but for the gun, imagine it was some type of road-making machine. Externally it appeared as a large diamond-shaped steel

box, with protuberances on either side from which poked a six-pounder gun and a machine-gun. Caterpillar tracks ran right round the edges, moving with a fearful clatter which, together with the open exhaust, the first tanks had no silencers, produced a fearsome effect. Trailing behind the tank were two wheels which were called the hydraulic stabiliser, the purpose of which was partly to control steering and partly to enable the tank to take considerable drops. These wheels were only used in the first 'Mark I' tanks; in actual war conditions they were found to be an unnecessary complication. Two types of tanks were made, the 'male' and the 'female,' the difference being in armament. The male carried two six-pounders and four machine-guns, the female six machine-guns, saving a ton in the total weight. They were nearly 26½ feet wide and 8 feet high, but the female with a width of 10½ feet was three feet narrower than the male. The female carried 31,232 rounds of small arm ammunition, the male 324 rounds of shell and 6,272 rounds of small arm ammunition.

Entrance to the tanks was gained either through small doors in the sponsons carrying the guns or through a manhole in the roof. The interior was very bare as to the walls and very hot. With all the ammunition, and rations that had to be carried the little space not taken up by the engine, driving seat or guns, was very crowded. The engine was a 105 h.p. Daimler six-cylinder and the driving arrangements rather complicated. The driver only had control of the primary two-speed gear-box. There was a second two-speed gear-box operated by two 'gearsmen,' and as the noise inside with the engine running made shouted orders quite inaudible, a code of hand signals had to be arranged between the driver and his gearsmen. Steering depended upon varying the speeds of the two caterpillars, running one in neutral, and braking, so that it was rather a complicated matter involving four members of the crew. Mark I. tanks were, in fact, very difficult to turn on rough ground.

The gunners at the six-pounders worked in cramped quarters, the recoil of the gun carrying the breech right past them; they had shields as protectors. Their mates kneeling on the floor reloaded, and in between times worked the machine-gun.

Performance of the tanks was: bottom gear a speed of about ¾ m.p.h., and top speed 4 m.p.h. On rough country the tank would average 2 m.p.h. The all-round caterpillars and the pointed front gave it very great climbing power. On average ground it could

ascend a gradient of 1 in 2½, it could climb over an obstruction 6 feet high with a following drop of 12 feet. It could cross any ordinary trench, and ditches nearly half its length, i.e., about 12 feet. Its great weight gave it enormous destructive power, walls were knocked flying, machine-gun posts simply flattened, and barbed wire torn away as if it were cotton.

The first crews soon discovered the vehicle's weaknesses: its tendency to get 'ditched,' its disinclination to be steered on rough ground, the ease with which it got hung up or 'bellied' on a small obstruction such as a tree stump which lifted its caterpillars clear of all grip, and its utter helplessness in really thick mud. This was quite apart from mechanical weaknesses and such discomforts as the terrific heat inside in spite of a fan; the bumps or swaying which threw men against hot pipes unless they were careful. An appalling atmosphere of cordite fumes and oil when in action completed the picture.

With a very limited number of these vehicles and a few 'Little Willies' which never went into action as they were of little use in practice because of their defective balance, the Heavy Section of the Machine Gun Corps went to work. They had virtually to train themselves, for there was no experience to go upon. Fortunately, they had Colonel Swinton, who had now given nearly two years to thinking and writing about tanks, but they had only a limited time in which to master the intricacies of the tank machinery, steering, and general use in action. They were given just three months with actual tanks to practise with the revolutionary weapon, and it is remarkable that in this period every man mastered the machinery to the extent of making running repairs as well as the difficult art of shooting from the heaving platform, steering the tank with its very limited visibility and other matters. It was possible only because the men were enthusiasts who threw themselves wholeheartedly into their task.

In the middle of 1916 it was decided that tanks should be used later during the year. This was completely against the principles laid down by Mr. Churchill, Colonel Swinton and others that the tank should be kept back until it was available in large numbers so that the element of surprise should be decisive. There was no possibility of a handful of tanks attaining final victory, although they might secure a local advance. Three or four hundred tanks might make the 'break through' which was at once the aim and the despair of both belligerents. Large numbers would not have been available until 1917, but they might well,

we now know, have ended the war a full twelve months before its final conclusion. Mr. Churchill was horrified when he heard the decision and made strong representations against such folly. Historians have held that the use of the tanks on the Somme in 1916 was a fatal error, and so, perhaps in the light of later knowledge, it was. But there was some method in the madness of the authorities who made the decision. The position was not quite as simple as it seemed. The vital question to them in 1916 seemed not so much whether we could beat the Germans in 1917 or even in 1918, but whether we could prevent them beating us in 1916. The risk was that in planning entirely for the future they might find themselves in the position of having no future. Prospect of victory next year is useless in face of probability of defeat this year. This was the broad idea that seems to have led to what we can only call the premature use of the tank.

The military problems on the Western Front could be crystallized into the smashing of barbed wire and the protection of infantry against machine-guns. These two vital requirements were interconnected. Barbed wire held up the infantry and the machine-guns mowed them down while they were exposed. The only solution that the generals of either side had yet devised was intense artillery bombardment to cut passages through the enemy wire and, as far as possible, demolish his strong points. The cry was for shells, shells, and more shells. But to make these shells we required factories, materials, and trained workers, so that although a prodigious output of shells was planned, in 1916 it was not yet available. Hundreds of thousands of shells had been used in the Battle of the Somme. The million or more rounds considered an essential preliminary to any large-scale attack on fortified positions were not ready. Yet something had to be done. To the military higher authorities it seemed just possible that the tank offered an opportunity of making some decisive gain in the Somme battle which had now been raging for three months with fearful casualties. Major E. W. Sheppard, in *Tanks in the Next War,* sums up the matter very fairly:

> 'Should a different policy have been adopted? In the light of our *ex post facto* wisdom, that harsh light of which every critic and historian should be, but is not always aware, it is easy, indeed, inevitable, to answer Yes. But it may in fact be reasonably argued that the policy of holding back the tanks till they could be used in mass in 1917—which would have

been the only possible alternative to using them in driblets in the autumn of 1916—was in fact not a possible one, given things as they were. It would in fact have meant to surrender the possibility of present slight advantage for the remote chance of future gain, a gamble on highly irregular and unorthodox lines. . . . Haig was not fashioned from gambler's clay, nor, perhaps, had he been, would he have held or deserved his high place. So the rude yet precious weapon that was the first tank was drawn prematurely from its sheath and untimely revealed to a world at war.'

The opinion of Mr. Churchill which is quoted later, was very different.

What the British deserved for throwing away this weapon was that the Germans should take a leaf out of their book, imitate the weapon and defeat them with it in a few months. Fortunately there were elements as conservative in Germany. The very misuse of the tank, as will be shown, led to its underestimation by the enemy. They had two years' warning, but took no serious steps to combat it or to build tanks until it was too late.

The circumstances explained decided both the date for the first use of the tank, the earliest which was at all practicable, and the venue, the Somme battlefield. The position and the method in which it was proposed to use the weapons was entirely against the basic principles laid down by those who had been concerned in developing the tank and who knew its limitations as well as its possibilities. They had explained that the tank should be used on reasonably firm ground; the Somme battlefield had been churned by thousands of guns until it was a morass. They insisted that the tank should be used without preliminary bombardment, not only to avoid cutting up the ground, but to achieve surprise. This idea of preliminary bombardment was so deeply implanted that it was impossible to argue against it. Not for months was it realized that a bombardment is a warning, sometimes days ahead, telling the enemy that an attack is being prepared. Our experts insisted there must be co-operation with the infantry. The tanks came as a surprise to our own infantry as well as to the enemy. There had been no rehearsals, only a few days to confer with the Higher Command on the tactics to be used. Fifty tanks were sent to France during August; some of their crews had never had a practice tank of their own up to this time. They had ten days for overhauling and practice. They reached the Front on 10th

September; and went into action five days later. In these fifteen days their officers and crews had not only to keep their tanks in condition, the first tanks were not mechanically reliable, but to discuss and decide upon a hundred points. How long before the infantry should they start, what course they would take and where they would store their 'battle luggage' which had only just been issued to them; these were only a few of their difficulties.

This 'battle luggage,' incidentally, seems to have been far too elaborate, including considerable quantities of food and even 100 yards of telephone wire which was supposed to be unrolled by the tank as it passed over its own trenches. On the other hand, officers were only given one map for every three tanks, showing how little the importance of reconnaissance was appreciated.

There was no doubt that the first employment of tanks was full of blunders, but can anyone quote a weapon that was born perfect and correctly used on the spot? Facts prove that only actual test under war conditions can answer many questions. Many men gave their lives because mistakes had been made. But not in vain. They paid the price of ultimate victory, victory achieved with the saving of the lives of thousands, hundreds of thousands, of infantry as the direct result of the tank and its men.

Chapter Three

FIRST BATTLES OF THE TANKS

THE preliminaries to the first action of tanks in battle were inauspicious. 'The orders, maps and time-tables issued to the commanders were insufficient, only one set being available for three tanks; consequently they had to be almost learnt by heart and then passed on to the next tank. But even this turned out to be useless, for at 5 p.m. on the day before the battle all orders were suddenly cancelled and fresh ones given verbally.'[1]

As soon as night fell on 14th September, 1916, the tanks began to move up towards their starting-positions, itself something of a feat in pitch darkness amidst the confusion of a Somme battlefield. Thirty-two reached their starting-places, many of them very uncomfortable as they were in close proximity to our batteries and the noise to men who were making their first visit to the lines seemed terrific. There was little sleep for the

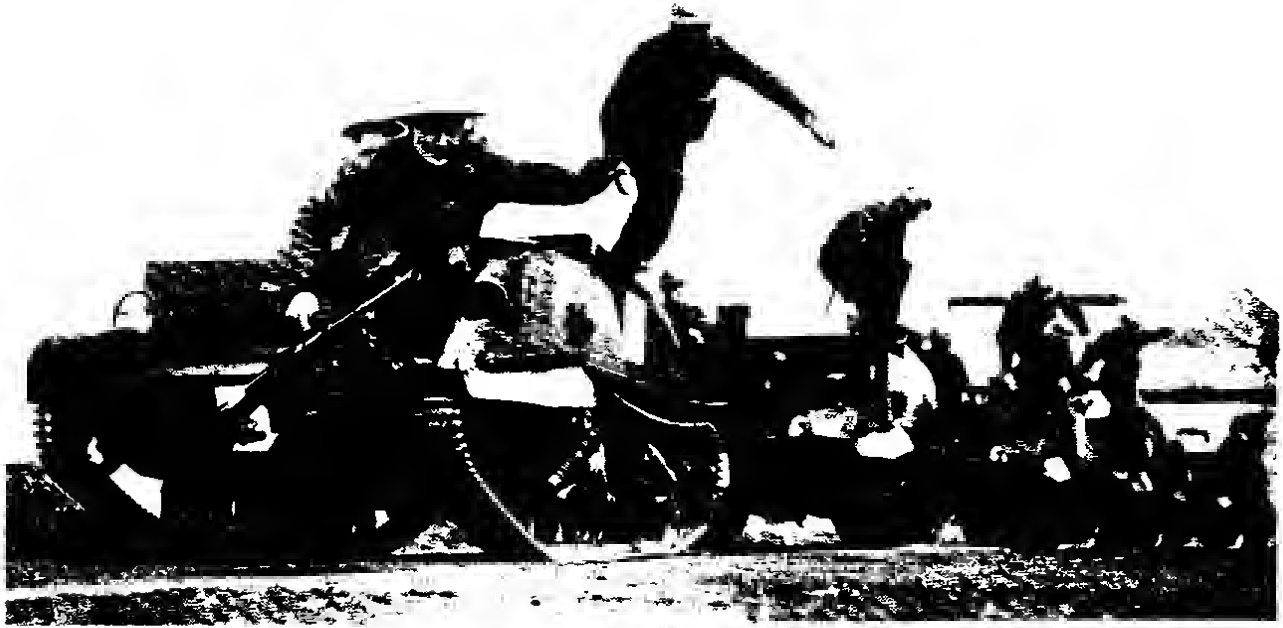
[1] *Tank Warfare*, by F. Mitchell, M.C.

crews that night, they had had scarcely any for several days. At 6 a.m. on the 15th the British barrage opened up. As it moved forward, the tanks crossed the trenches and began to lumber across no man's land, followed by the infantry.

It would be impossible to follow the exploits of each tank. Two were noteworthy, more because of the effect they had on general opinion than for their influence upon the battle as a whole. One tank took the village of Flers single-handed. It was being followed by New Zealand infantry, and these men who anticipated the appalling casualties that had become so usual. found that the Germans fled in terror at the sight of the tank, and that they had nothing to do but follow it and 'mop up.' They did not lose one man. Another tank seated itself astride a German trench and began to enfilade it, whereupon the Germans surrendered and the tank, travelling along the trench, took three hundred prisoners. But the results of the battle were inconclusive. There was no 'break through.' A few more hundred yards of shell-torn ground was taken and, considering the force employed, the tanks did not seem, on the whole, a decisive weapon. Forty-nine tanks set out, thirty-two actually reached their starting-points to take part in the action. Nine had mechanical trouble and broke down, five became ditched, and nine did not keep up with the infantry. The real successes were attained only by nine out of forty-nine tanks, although some of those which were out of action or failed to keep pace with the advance did good work in clearing up by acting as rallying-points.

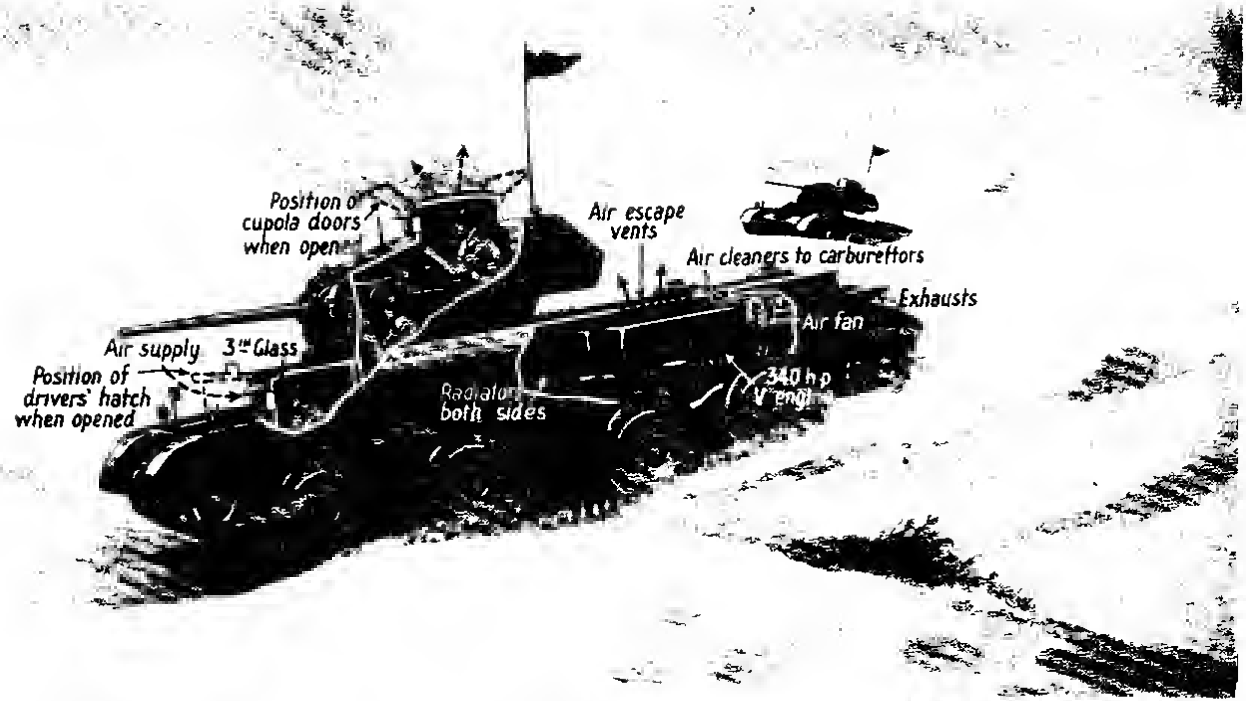
The material effects of the first tank action were small. But the moral effects were tremendous. On the German side, the mere appearance of the tanks caused panic, and the way in which the tanks crushed machine-gun posts, guns, sandbags, gunners and all, showed the Higher Command that they were a very potent weapon. Documents captured later showed that the Germans had been genuinely scared; that they were indeed making frantic efforts to encourage their soldiers to stand their ground and fight. They set about devising anti-tank plans immediately, but, fortunately for the British for reasons indicated later, the 'scare' died down and anti-tank measures, except for the production of armour-piercing bullets, were not taken too vigorously.

On the British side, the tanks, in spite of the failure of so many, won the immediate admiration and confidence of the infantry. For two years they had been flung unprotected again and again against barbed wire and machine-guns. Here was something that,



ROYAL FUSILIERS

Bren gunners rushing from the carriers to take up position



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BRITISH CRUISER TANK

In desert warfare air supply is important. When all hatches are closed for action the interior heat is terrific and calls for perfect physical fitness of the crew. The engine cooling system is automatically controlled.

at any rate, gave them a chance. Here was something to make Jerry as scared as they had been when they first met flame-throwers and poison gas. In their enthusiasm they vastly exaggerated what a tank could do. Sir Albert Stern, in *Tanks 1914-1918*, quotes an amusing letter from a soldier to his 'girl'—'They can do up prisoners in bundles like strawbinders, and, in addition, have an adaptation of a printing machine which enables them to catch the Huns, fold, count and deliver them in quires, every thirteenth man being thrown out a little farther than the others. The tanks can truss refractory prisoners like fowls prepared for cooking, while their equipment renders it possible for them to charge into a crowd of Huns and, by shooting out spokes like porcupine quills, carry off an opponent each. Though "Stuck up," the prisoners are, needless to say, by no means proud of their position.

'They can chew up barbed wire and turn it into munitions. As they run, they slash their tails and clear away trees, houses, howitzers and anything else in the vicinity. They turn over on their backs and catch live shells in their caterpillar feet, and they can easily be adapted as submarines; in fact, most of them crossed the Channel in this way. . . . They spin round like a top, only far more quickly, dig themselves in, bury themselves, scoop out a tunnel and come out again ten miles away in half an hour.'

Of course, this soldier was gently pulling his sweetheart's leg, and had probably never seen a tank, but the letter illustrates the new feeling of hope and buoyancy which the tanks brought. The fearful blood and mud baths of the Somme were forgotten in the hope that this new weapon would pave the way to victory in the face of German machine-guns.

Perhaps even more important was the effect on the British High Command. Sir Douglas Haig, who had not heard of tanks the previous Christmas, was very impressed and plans were made for getting 1,000 tanks as rapidly as possible. Indeed, enthusiasm was such that the real lessons of the battle do not appear to have been learned, except perhaps by the officers and men who had manned the tanks. They were the only people who were not exhilarated. While the whole of Britain, now that the secret was out, was smiling at the story of the aeroplane which flying low over the battle had reported: 'A tank is walking up the High Street of Flers with the British Army cheering behind,' the tank men were considering the results dispassionately with a feeling of failure. It was due to their knowledge of what might have been

if only the ground had been better chosen, the tactics more suitable, the time for reconnaissance and preparation longer. They saw—as the Germans saw, that if the attack had been carried out by a thousand tanks on the same front, the whole German trench system would have been rolled up and the tanks would have gone 'to the green fields beyond' where cavalry could have fanned out and turned a defeat into a rout. 'To the green fields beyond,' indeed became the dream of the tank men, a dream that was not to be wholly realized for another two years.

The tanks that survived the first day were employed in a series of minor actions right up to November, when the state of the ground which had been steadily deteriorating in the rain made the use of the tanks altogether impossible. The result of these actions was twofold. The crews obtained further experience which confirmed their ideas of the possibilities of their machines and taught them the importance of several points, notably the need for preliminary reconnaissance of the ground to be covered. But the continued use of the tanks in unsuitable country and the wholesale ditching and bogging which followed had somewhat damped their enthusiasm. The Higher Command were quite pessimistic; they could not realize that lack of success was almost wholly due to wrong tactics. Tanks were being employed in twos and threes, and on unsuitable ground.

In some actions, all the tanks concerned were bogged or ditched before they could do anything. But in others they rendered brilliant service. For instance, against Thiepval, a most formidable trench fortress, eight tanks were used without a preliminary bombardment. The position was taken very quickly, the Germans being actually caught in their dug-outs before they could bring up machine-guns.

In the action against Beaumont-Hamel later in the month the almost hypnotic effect of tanks on the German infantry was demonstrated. Two tanks were called upon to clear up a 'pocket' of Germans who were well-entrenched and had resisted resolutely all day. The two tanks became stuck in the middle of the enemy and were almost powerless. A few bombs would have put them out of action. The Germans, however, did not realize this, and, becoming panic-stricken at the sight of the monsters, surrendered in a body. The infantry, grasping the position, rounded up about four hundred Germans very quickly in case they should suddenly realize that the tanks were, in fact, temporarily out of action.

Action by tanks finally ended on 18th November, because

of the rapidly deteriorating weather conditions and the reduced number of tanks. The remnants retired to 'winter quarters' in preparation for the Spring offensive which was proposed on a much larger scale. The Heavy Brigade of the Machine Gun Corps had been rapidly expanded, the proposal being to have three brigades, each of three battalions of seventy-two tanks, by the Spring. This involved training many thousands of men and the only instructors were veterans of the tank actions held during the Autumn. They were the very best instructors, for actual battle experience had shown the need for additional and different types of training. Colonel Swinton had thought out the system of laying white tapes to guide tanks across no man's land, the best methods of dealing with machine-gun posts and field guns had been found and the importance of rehearsal or co-operation with the infantry, appreciated by the tank officers, if not by the General Staff.

Experience also showed how the tank itself could be improved, and modifications were made in the construction of the Mark II tanks which were being built to complete the order given for 1,000. The chief changes were the removal of the hydro-stabilizer, the two wheels at the back, and the introduction of a 'torpedo boom' to assist in unditching. This was a boom about six feet long, normally carried on top of the tank, which could be attached to the caterpillars so that it was pulled underneath to give support. An exhaust pipe cover was introduced; some crews had used empty petrol tins to reduce the noise and flame of the open exhaust. Track-rollers and sprockets were cast in new material to give longer wear. The introduction of the Lewis gun with its vulnerable barrel in place of the Hotchkiss was not undertaken with the approval of the tank officers, nor was it an improvement in any sense of the word.

In addition, plans were approved for a very much superior Mark IV tank, the first of which were to be ready in March, 1917. Deliveries did not come up to plan, not surprising considering the difficulty of materials and the constant giving or cancelling of orders. It will be recalled that immediately after the first tank battle 1,000 tanks were ordered. On 10th October, the Army Council cancelled the order. Fortunately Lieut. Stern approached Mr. Lloyd George on the matter; Mr. Lloyd George knew nothing of it, and he had the order reinstated immediately. The War Office, temporarily defeated in its effort to get rid of tanks, made a brilliant flank manœuvre. It 'promoted' the greatest expert on tanks, Colonel Swinton, to the Committee of Imperial Defence.

We cannot follow all the manœuvres of this astonishing war against the tanks which was waged to within three months of the Armistice, but the orders seemed to vary in accordance with the temporary success or failure of tanks in battle. Given such varying controls, 'growing pains' were, perhaps, inevitable. They were the background to all the tank battles of the next eighteen months, and they troubled the higher officers rather more than the men in the tanks. They, indeed, were desperately anxious to prove themselves and their machines. They showed limitless resource and courage which on occasions amounted almost to foolhardiness. Far from being 'safe' in their steel boxes, they suffered tremendous casualties, as high proportionately, as the infantry in the bloodiest of battles.

Training was carried out under great difficulty. Four battalions, under Colonel Elles, who had been appointed to the command of tanks on 26th September, were formed, but they had only sixteen workable tanks; two hundred and twenty tanks should have been delivered during the first three months of 1917, but only sixty were available for the Battle of Arras in March and few of them were of the Mark IV type, with armour-plating to resist the armour-piercing bullets which the Germans would certainly have produced during the winter. The tanks were thinly spread on a wide front so that to give a complete account of the action it would be necessary to follow the individual fortunes of each tank. We must be content with a brief account of certain significant actions.

Six tanks were ordered to attack the village of Monchy-le-Preux on 11th April, in the usual way. There was to be a barrage, waves of infantry and cavalry were standing by to take an advantage of a break through. At the last moment 'zero hour' was postponed for two hours, but by some mishap the tank commanders were not told. They were a little puzzled when the expected barrage did not open at 5 a.m., but decided to carry on. The Germans, without the warning of the barrage, were taken by surprise. The tanks took the village with ease and without a casualty, and passed well beyond. Unfortunately, there were no infantry to hold the village, the Germans returned, and the tanks found themselves cut off. They tried to change direction, but found the Germans well prepared. Worse still, our own barrage opened up and knocked out every tank. The end of the action was the advance of our infantry and the capture of the village by hard fighting. A cavalry charge ended in almost massacre. But

the lesson, that the effectiveness of tanks was greatly increased without a preliminary barrage, was there for anyone to see, and it was this which laid the foundations for the Battle of Cambrai.

Less fortunate was the First Battle of Bullecourt, in which tanks were to assist the Australians. Snow had fallen and the tanks were silhouetted against the white. The Germans had armour-piercing bullets. The result was that in a short time nine out of eleven tanks were out of action. In one tank a hail of bullets shattered five out of the six Lewis guns and wounded five of the crew. Two tanks advanced successfully with about two hundred Australians, but the Germans swept round and captured them all. The loss of the two tanks 'taken alive' was serious, for the Germans could examine them, discover the effect of their bullets and obtain secrets of our tank construction. An incidental result was that the Australians lost all faith in tanks and would have nothing to do with them for more than a year.

Casualties during the battle were very heavy in men and machines. By 3rd May, when the last attack was made, only twelve tanks were capable of repair and going into action again. Once more, tanks had accomplished nothing decisive. But the individual exploits of the officers and crews who again and again had shown amazing courage in bringing their tanks back when severely wounded, continuing to fight even when their tanks were out of action, had won the respect of the infantry. Moreover, the tanks' astonishing ability to capture in a day objectives which, on the Somme, would have taken a week, was appreciated by the Commander-in-Chief. Colonel Stern records that after the battle Sir Douglas Haig told him that a division of tanks was worth ten divisions of infantry, and that tanks were the most important weapon to the army after aeroplanes. Major Williams-Ellis summarizes the lessons of the battle thus:

> 'Tanks should be used in masses. They should be concentrated. A large reserve should always be on hand. Mark I machines were not suitable for wet or heavily shelled ground. Signal and supply tanks were essential.'

The next large battle in which tanks were used was Messines. It was notable as the first time when the new Mark IV tanks were present in numbers. These tanks, apart from better armour-plating, which could not be penetrated by the German 'K' bullet, had other improvements, notably the removal of the petrol tank

to the back and outside of the machine, thus reducing the risk of fire, and of improved sponsons which could be drawn in for rail transport. With a speed of 4 m.p.h. and their short life or range, any movement, except in the immediate rear of the battlefield, had to be carried out by rail. The lessons of Arras were put into practice. Nearly half the available force of tanks was kept in reserve, some to act as supply tanks with petrol and ammunition, some to follow up the first wave. Seventy-two tanks took part in the attack. Thanks to the stunning effect of the million pounds of explosive which had been buried under Messines Ridge, the tanks had little to do and many reached their objectives very quickly. The Germans must have been very disheartened to find their 'K' bullets ineffective against the new machines.

Messines was followed by the most terrible and hopeless tank battle of the war, where the failure of the tanks, in conditions more suited to battleships than tractors, nearly resulted in all confidence being lost again. Between the time of Messines and the Third Ypres, incidentally, the name Tank Corps was officially adopted. Even the War Office was now willing to admit that the tank was no longer a secret.

The story of the Third Battle of Ypres has been told many times; Passchendaele will always remain a name of sinister and glorious memory. Here, we must limit ourselves to the action as it concerned the tanks. They were beaten, or rather, put out of action not by the Germans, but by the terrain and the weather. The battlefield consisted of a stretch of marshy ground, a slight ridge, a gentle descent to more marshy ground and then another ridge. On this battlefield two great armies had fought for nearly three years. Countless shells had torn the ground, destroying what drainage there was and turning it into a swamp of mud quite a number of feet deep in many places. The danger of being drowned was almost as great as the danger of being blown up. No more unsuitable place for tanks could have been found along the whole Western Front, unless they had been asked to swim actual rivers. The only excuse for the battle was, as on the Somme, that a battle was 'necessary.' Expediency had to triumph over commonsense.

Bad as were the conditions, they were made worse by the preliminaries to the battle. The vast troop movements, the accumulation of ammunition and supplies necessary for a big battle gave the enemy weeks of warning. He built concrete pill-

boxes and he shelled transport methodically so that movement had to be made at night. Then again, instead of the surprise attack without bombardment which experience had shown was most effective with tanks, there was to be the biggest preliminary bombardment of the war lasting a total of twenty-four days. Any part of the country which was not a swamp was effectively rendered almost impassable in this way. The generals' argument in favour of the bombardment was that it was essential to give the infantry a chance, and that the good it did for the advance as a whole was greater than the evil done to the tanks. They seemed incapable of simple logic.

To complete the misery of all, rain began to fall heavily on 31st July, the day of the attack, and continued without respite. The tanks had been fitted with a new device, the unditching beam. This, as has been explained, was a huge iron-shod teak beam, rather longer than the tank was wide, carried on top and ready to be dropped by guide rails to the ground when the tank became bogged. Even this was incapable of getting the tanks out of the swamps into which most of them floundered, although it saved them on many occasions on ground that would otherwise have held them fast.

Three brigades of tanks were employed in the first attack, and in each case they were to attack in 'waves,' with a good number held in reserve. No trouble had been spared in preliminary reconnaissance; a huge scale model of the battlefield had been made so that every ruin, stream or other landmark was absolutely familiar to every officer. All this was to be wasted in face of the conditions. On the first day, although many tanks became stuck and in this position fell victims to the enemy's artillery, most of them reached their objectives and a big haul of prisoners was made. But the rain had increased during the night and, in the words of Sir Douglas Haig, "The valleys of the choked and overflowing streams were speedily transformed into long stretches of bog impassable except by a few well-defined tracks which became marks for the enemy's artillery. . . . To leave these tracks was to risk death by drowning. . . ." For a fortnight there was nothing that infantry and tanks could do but be soaked by the rain and look out on a sea of mud while the enemy artillery shelled steadily.

Towards the end of August there was some improvement in the weather, and up to 9th October tanks were employed in a number of minor actions. It is impossible to follow these in

detail, and perhaps the matter is best summarized in Sir Douglas Haig's Despatch:

> 'Although throughout the major part of the Ypres battle, and, especially in the later stages, the conditions of the ground made the use of tanks difficult or impossible, yet whenever circumstances were in any way favourable, and even when they were not, very gallant and valuable work has been accomplished by Tank Commanders and crews on a great number of occasions. Long before the conclusion of the Flanders offensive these new instruments had proved their worth, and amply justified the labour, material and personnel diverted to their construction and development.'

Sir Douglas Haig showed much greater foresight than some of his generals. Indeed, the opinions expressed about tanks were so forcible that the rumour went round that they were to be entirely scrapped. The claim was, roughly, that tanks were unable to cover ground badly torn by shellfire or waterlogged, and that since all battlefields would of necessity be of this type, tanks were useless. This argument seems to have prevailed at home, for on 11th October, Colonel Stern was told that the order for four thousand tanks for 1918 would be cut down to one thousand three hundred and fifty, and when he protested at the inadequacy of this amount he was given the position of supervising tanks in France and the U.S.A. It is said that those responsible for trickery of this kind are seldom brought to book.

The British Army suffered 400,000 casualties in the battle, and the Tank Corps had more than its share. When crews could get their tanks up to the enemy's line they fought with desperate courage and astonishing determination, anxious to prove themselves. They must have been aware that the Corps was, in a sense, on trial. Some of the minor actions proved points of great interest. They showed, for instance, that tanks were ideal for dealing with the pill-boxes which were proving so murderous to the infantry. Four pill-boxes hidden in ruins of farmhouses were taken by twelve tanks, and instead of the casualties being 600 to 1,000 as estimated by the commander of the infantry, no more than fifteen men were wounded. The tanks went behind the pill-boxes, which were isolated by a smoke barrage, and forced them at their most vulnerable point. Another point learned was that familiarity had not made the Germans treat tanks with contempt. On the contrary. Their morale when faced

with tanks was low, and in several instances they surrendered immediately the tanks appeared. Most important of all, a few tanks correctly employed in a minor operation with the Army Corps of General Maxse had, by their success, paved the way to Cambrai.

The First Battle of Cambrai was that which the creators of the tank had visualized, the battle for which they would have held back the tank if they could have had their way. It was to be an action primarily designed to destroy the enemy rather than take a few thousand yards of land, and surprise was to be ensured by omitting the preliminary bombardment which had preceded every battle fought on the Western Front up to that time. The spot was specially chosen as suitable to tank action and the idea for the raid, for that was how the battle was originally planned, was put up by General Elles. He approached Sir Julian Byng, commanding the 3rd Army in the terrain most suitable for tank action, undulating chalk almost unscarred by shells and, being one of the quietest spots in the line, likely to increase the element of surprise. General Elles and General Byng worked out the plans for a large-scale raid by tanks and submitted it to G.H.Q. They were told that they must wait until the Battle of Ypres had finally concluded. That battle petered out without any decisive gains, and the generals were given permission to put their plan into execution on 20th November. They had one month to prepare it and to assemble the tanks. The idea was, in essence, simple. Tanks were to attack, pass over the enemy's trenches and destroy his guns which would also be receiving the attention of bombing aeroplanes. A second wave of tanks was to attack trenches and be followed by a third wave. The rôle of the artillery was to be attack on the lines of communications and heavy guns well behind the lines. Four lines of trenches were to be taken and the whole action to be completed in twenty-four hours.

As the plan grew, it was expanded. The length of the action was extended to forty-eight hours, six divisions of infantry were to follow the tanks and two divisions of cavalry were held to pass through the gap.

The German defences here were part of the famous Hindenburg Line, which they, and perhaps some of the Allied generals, thought was impregnable. It was immensely strong, making great use of the undulating country and having four lines of trenches up to 15 feet wide. Acres of barbed wire, averaging

50 yards in depth, protected the system. The trenches were too wide to be crossed by tanks. A method of crossing by the use of fascines, great bundles of brushwood which would be dropped into the trench, was devised. By superhuman efforts three hundred and fifty of these fascines, each made by compressing sixty to seventy bundles of brushwood in chains, two tanks being used to pull them tight, were made in three weeks. Each of these bundles weighed 1½ tons.

The method of use was thought out by Colonel Fuller, who devised a 'drill,' which was practised until the tanks were perfect in its execution. Briefly, the first tank went up to the wire and swept the advanced trench with its fire, giving some protection to the second and third tanks. The second tank ploughed through the wire, dropped its fascine in the trench, crossed and turned to the left. The third tank crossed on the second tank's fascine and travelled on to the second trench, where it dropped its own fascine and after crossing worked along its length. Meanwhile the first tank crossed over the first and second trenches on the fascines laid down, to drop its fascine in the third trench, which it could then cross.

Much of the success of Cambrai was due, undoubtedly, to the practice which infantry and tanks had together, even though it was for a limited period. Somebody with real understanding, probably Colonel Fuller, appreciated that the infantry must have complete confidence in the tanks, a confidence somewhat lost at Ypres. The tank officers had offered the infantry a friendly bet that they could not erect any wire- or trench- defences that the tanks could not cross. The infantry did their worst, but the tanks ploughed through the wire and crossed the 'test' trenches. The result was that by the time the battle approached, the infantry had great faith in the tanks that were to lead them forward.

General Eles gathered every tank in his force for the attack. By superhuman efforts the salvage crews had got no less than one hundred and ninety out of the mud of Ypres, and one hundred and twenty-seven were made ready for the battle. Altogether a formidable force of four hundred and seventy-six tanks was collected, three hundred and eighty-seven for fighting and the rest for carrying supplies, pulling away wire or bridging. No less than nine were fitted with wireless, the first time, as far as can be ascertained, that wireless was used, and, if only for this reason, an historic occasion.

Some idea of the immense preparation necessary even for this limited battle can be gathered when it is explained that thirty-six trains were required to carry the tanks. More than 165,000 gallons of petrol, 541,000 rounds of six-pounder ammunition, 5,000,000 rounds of s.a. ammunition had to be brought up by light railway and then carried to the forward positions. Great pains were taken to keep the secret of the attack, even to the extent of letting false plans fall into the hands of the enemy and resisting a natural desire to increase aerial reconnaissance. In actual fact, the Germans made a raid and took prisoners on the previous night, obtaining evidence that action was contemplated. Instructions to issue armour-piercing bullets were found in their quarters, but it was too late.

The attack was a complete success. The German infantry were overwhelmed and the tanks swept over the trenches to the country beyond. Penetration was made to an average of over five miles, headquarters were seized, huge amounts of stores with one hundred guns were captured and 8,000 prisoners taken. The total British casualties were 1,500. Colonel Fuller, in his *Tanks in the Great War*, says: 'It is a question whether any stroke of the allied army on the Western Front was more fruitful ultimately of ground and result than the battle of Cambrai, despite its limited design.'

This was the battle that Mr. Churchill, Colonel Swinton and other pioneers of the tank had visualized on a far larger scale.

> 'If British and French war leaders had possessed, not more genius, for the possibilities had by this time been obvious to all who were studying the tank problem, but the vision and comprehension which is expected from the honoured chiefs of great armies, there was no reason why a battle like Cambrai could not have been fought a year before, or better still, why three or four battles like Cambrai could not have been fought simultaneously in the spring of 1917?'

Thus Mr. Winston Churchill, in *The World Crisis*, and he answers the inevitable questions, could three thousand tanks have been built, the men trained, the preparations kept secret by saying that 'one-tenth of the mental effort expended by the Headquarters staff on preparing the old-fashioned offensives of which the war had consisted, one-twentieth of the influence they used to compel reluctant governments to sanction these offensives, one-hundredth of the men lost in them, would have solved all

the problems easily and overwhelmingly before the Spring of 1917. . . . Accusing as I do without exception all the great ally offensives of 1915, 1916 and 1917, as needless and wrongly conceived operations of infinite cost, I am bound to reply to the question, "What else could be done?" And I answer it, pointing to the Battle of Cambrai, "This could have been done." This in many variants, this in larger and better forms ought to have been done, and would have been done if only the Generals had not been content to fight machine-gun bullets with the breasts of gallant men and think that was waging war. . . .' The quotation is of special interest in view of the events of the present war, when again the cry is, 'Tanks, tanks and more tanks.'

Cambrai was remarkable as the first battle in the Great War in which a general led his troops into battle. The nature of modern warfare seems to demand that he should be far behind the lines. General Hugh Elles, in his Order, stated: 'I propose leading the attack of the Centre Division,' and he went into battle with the brown, red and green flag of the Tank Corps from 'Hilda.' It was a warning of the revolution in warfare which the tank was to bring about, a revolution that was not really appreciated until more than twenty years later by authorities whose only distinction was that of almost criminal prejudice.

Cambrai did not end so successfully as it had begun. One great mistake had been made; no tanks had been kept in reserve. The result was that when the Germans counter-attacked they did well. Tanks that could be assembled were thrown into the battle, but the crews were tired, and there is an end to endurance. They stemmed the counter-attack, but had then to be withdrawn with the prospect of no more fighting until the Spring of 1918.

During the winter, tanks were in favour. There were limits to the expansion possible because of the heavy demand for other material, aeroplanes, ammunition, lorries and locomotives. Large numbers of Mark IV tanks were on order, new types were added for salvage or supply tanks, a tank which was virtually a carrier for a 6-inch howitzer and, perhaps, most important of all, Whippet or Medium A tanks. These were quite different in pattern, much more like our modern machines. The caterpillars, instead of travelling all round the tank, were confined to a low body out of which rose a turret or 'fighting turret.' The crew was only three and the armament was three machine-guns. This model had not the climbing ability of the Mark IV tanks, but the

maximum speed was 8 m.p.h., and they were designed to follow the large tanks, pass through the lines and act as cavalry in disrupting the enemy behind. A Mark V tank was being built which was a considerable improvement on the Mark IV. It had a more powerful engine, was a little faster and, with the aid of epicyclic gears, could be entirely controlled by one man. The field of view from it was considerably better. A Mark VIII tank design was agreed upon, which was to be built by the Americans but, in practice, none were ready soon enough to go into action. Equally important, immense strides were made in training. Experience had now enabled thorough and practical courses to be arranged.

What the Allies might have done with their tanks in the Spring of 1918 will always be a speculation. The Germans acted first. The great German offensive which opened against the 5th Army on 21st March, with six thousand guns firing a barrage, while nearly a million men advanced to the attack, will have a place in every history book. The tanks played a part in stemming the attack, although it was not a duty for which they had been trained, and they worked under a terrific handicap. They suffered enormous losses. When the tanks were disabled, the men took out their Lewis guns and fought as infantry. It would be impossible to follow the many actions fought by tanks during the great retreat. 'Everywhere it was the same story of villages the question of whose ownership was "obscure," of gaps in the line which the tanks had to bridge for a critical hour or two, often firing their machine-guns into the advancing waves of the enemy until the guns grew hot and jammed, and the tanks had to retreat. Often they would go back till their petrol gave out, and the crew had to blow up their machines,' says Major Ellis-Williams, and that summarizes the matter. The Mark IV tanks could not keep pace with the retreat, and infantry commanders were unwilling to 'give them a run for their money,' knowing that their loss was inevitable.

April 23rd was another historic day, for on it for the first time in history tank met tank. The Germans had at last begun making tanks of their own, besides using patched-up captured tanks. They were heavier than the British tanks, and they had the same devastating effect on the British infantry as the Mark I tanks had had on the Germans. Fortunately the Germans seemed to have very few, and they were comparatively inefficient. On 23rd April, three German tanks came up against one British

'male' Mark IV and two females. The latter, armed only with machine-guns, were quickly knocked out, but the single British male, by skilful manœuvring, avoided enemy fire and got in three direct hits with its six-pounder on the leading German tank, putting it out of action. The other two did not wait, but turned tail. Thus ended the first tank-versus-tank battle in favour of the British. The results of the use of tanks in this offensive must have been encouraging to the Germans, for nearly everywhere they appeared they broke through the infantry. But the Germans had woken up too late. They could not manufacture tanks in any number in time. In any case, it is doubtful whether they then could spare the steel. They would have had to have made their tanks at the expense of some other weapon they could ill afford to lose, and this may well have been a factor in their failure to appreciate the value of the tank in offence, and the fact that it was only really sound defence against a similar 'moving fortress.'

Those were black days for Britain, black days for the Tank Corps, which had been planning for a great offensive and found itself being cut up in their attempt to stem an apparently endless flood of infantry. Hundreds of tanks were lost, and it seemed that, even if the tide of battle could be turned, it would be months before the machines could be replaced. Yet at the very moment when Haig was writing his famous 'Backs to the Wall' message, the Tank Corps received a telegram from the chairman of a great Birmingham company that was making tanks: 'A resolution has been passed unanimously by the Works people of the Metropolitan Carriage Company to forgo any holidays and to do their utmost to expedite the delivery of tanks to assist their comrades in the field.' It cheered them immensely and gave them hope that they would still reach 'the green fields beyond the mud and blood.'

The great offensive spent itself at last without the Germans having gained their vital objectives, although they had won a tremendous area of land, destroyed armies and put many hundreds of tanks out of action. The work of great reconstruction began. The delivery of tanks which had been held up during the offensive was expedited. Mark V tanks streamed into France at the rate of sixty a week. Not only their crews, but the infantry were impressed by their manœuvrability. Most important of all, perhaps, the Australians who had completely lost faith in tanks, watched every demonstration, and decided at last that tanks were 'worth while.' May passed with only very minor tank actions,

although one of them, a raid in which five tanks were used, was of interest because it was the first occasion upon which tanks were employed at night. They were completely successful.

The next major operation was Villers Bretonneux on 4th July, where it was decided to test out the strength of the enemy. The attack was carried out by sixty tanks accompanying Australian infantry. A notable feature of the action was the use made of tanks to carry supplies. Four tanks carried 12,500 lb. of ammunition and water, the equipment of the carrying capacity of one thousand two hundred and fifty men. Another feature was the co-operation of aeroplanes with tanks, foreshadowing the future. A squadron of aeroplanes was allotted to the tanks and did excellent work. The action was a complete success, and was remarkable for the fact that only three tanks out of the sixty were damaged and none lost. This was the rehearsal for the Battle of Amiens on 8th August, 1918, the 'Black Day' of the German Army, when its fate was sealed by tanks, when the Allies were to reap the harvest of two years of slaughter, when the Germans were to pay for their fatal error in failing to understand that the British had revealed to them the master-secret of modern war.

Four hundred and thirty tanks were used in this action, which was prepared in seven days, a contrast to the month given up before Cambrai. The first part of the battle resulted in astonishing success, sixteen thousand prisoners and two hundred guns were taken in two hours. Later on, the German resistance stiffened and the tanks suffered heavy casualties, but the whippet type went through according to plan and worked well behind the German lines. The exploits of armoured cars of the 17th Battalion of the Tank Corps were amazing. They had travelled one hundred miles to the field, went right through the lines towed by tanks, and were then let loose in the country beyond. They created confusion everywhere; one section penetrated ten miles and captured the Corps headquarters, from which documents were loaded into the car, which then returned safely.

Altogether nearly seven hundred tanks of various kinds were employed on this occasion, and the casualties were heavy; four hundred and eighty had to be retrieved by the salvage men. But the results attained were great. 'Within the space of five days, the town of Amiens and the railway centring upon it had been disengaged,' wrote Sir Douglas Haig in his Despatch. "Twenty German divisions had been heavily defeated by thirteen British infantry

divisions with three cavalry divisions assisted by a regiment of the American 33rd division and supported by some four hundred tanks. Nearly twenty-two thousand prisoners and over four hundred guns had been taken by us. Our line had been pushed forward to a depth of some twelve miles in a vital sector." Even greater than the material gain was the effect on German morale, evidenced by the instruction and orders of Ludendorff. What amounted to panic measures were taken to counter the effect of tanks. The infantry were told once more to stand their ground and fight to the last. N.C.O.s and men were to be encouraged to use their ingenuity in laying tank traps. Divisional orders began with the statement: 'The infantry must not let itself be frightened by tanks. The fighting capacity of the tank is small owing to the bad visibility, and the shooting of the machine-guns and guns is cramped and inaccurate as the result of the motion. . . .'

There was much more, all painting an unhappy picture of the experiences of tank crews: 'They are nervous and inclined to turn back,' and this had a curious effect. The Germans now decided to form their own tank corps on a large scale. But they had presented such a picture of the terror of tank crews that they were unable to get recruits.

In the short time available, the Germans did arrange remarkably good anti-tank defences of all kinds, and the losses in tanks during the great advance which ended in the Germans asking for an Armistice, were considerable. Nearly two thousand tanks were engaged in the many actions between 9th August to 5th November, and of these eight hundred and eighty-seven were disabled. During the year over two-fifths of the Corps fighting men became casualties. The enemy fought strongly right to the end, and there were no 'walk-overs.' On several occasions he used captured British tanks, and there arose the remarkable position of British soldiers protecting themselves with captured German anti-tank rifles.

Sir Douglas Haig summed up the matter:

> 'On the different battle fronts 187,000 prisoners and 2,850 guns were captured by us; also over 29,000 machine-guns. These results were achieved by fifty-nine fighting British divisions which in the course of three months of battle engaged and defeated ninety-nine separate divisions.
>
> Since the opening of our offensive on 8th August, tanks

have been employed on every battlefield, and the importance of the part played by them in breaking up the resistance of the German infantry can scarcely be estimated. The whole scheme of attack on 8th August was dependent upon tanks, and ever since that date on numberless occasions the success of our infantry has been powerfully assisted or confirmed by their timely arrival.'

The last tank action was by whippets at the Forest of Mormal, on 5th November; after ninety days' continuous fighting very few tanks remained fit for action. But their part in the final defeat of the enemy was acknowledged when on the 6th December the armoured cars of the 17th Battalion of the Tank Corps crossed the Rhine at the head of the British Army of Occupation and ran up the flag of their Corps.

In order to simplify the problem of 'tank origins,' no mention has yet been made of the research conducted by other countries involved in the Great War. The invention of tanks in France is of great interest, for it was made quite independently of Britain, and in many ways the Germans owed far more to Britain than did the French in so far as their early tank designs were concerned. The fact that the French had produced a tank and had given orders for eight hundred before they heard that the British were building a similar machine, is either a remarkable sidelight on the secrecy that was preserved or indicates the pitiful lack of co-operation between the Allies, which was clear to everyone except the Higher Command.

In Britain tanks were invented and developed by a number of men. In France, one man was responsible for their invention, development and employment. He was Colonel, later General, J. B. E. Estienne, an officer of the French artillery. The same fundamental problem, that of breaking wired lines well protected by machine-guns, set him to think of tanks quite early in the war. It was the watching of Holt tractors at work towing guns behind the lines that suggested the solution. On 1st December, 1915, at about the time Mr. Churchill was writing his *Variants of the Offensive*, Colonel Estienne wrote to the French Commander-in-Chief, suggesting a fighting vehicle very much along the lines conceived by Colonel Swinton, and asking for an interview. This was granted and Colonel Estienne greatly impressed his superiors by his argument. He was given permission to visit the noted Schneider works and to discuss technicalities. He collaborated

with M. Brille of this firm in designing a fighting vehicle, and at the end of February the French placed an order for two hundred *chars d'assaut*. A little later a further order for four hundred vehicles was placed with the St. Chamond works; a Training centre being set up at Marly le Roi and at Champlien.

Later in 1916, the French headquarters heard of British experiments, and Colonel Estienne was sent to Britain to see the first Mark 1 tanks. The French took a very sensible view of tanks, asking for collaboration and specialization—Britain was to build heavy types, and the French, light models. They also made a point that neither ally should prematurely disclose the existence of tanks, and that they should combine in a large-scale assault. This was not agreed, and the British tanks went into action before the French tanks were ready. Indeed, it was not until five days after the first tank action on the Somme that the French formed the equivalent of our Tank Corps, the Artillerie d'assaut, with Colonel Estienne in command.

These French tanks differed from the British in one important respect. The caterpillar tracks did not go round the entire tank, but only over a low chassis, out of which a fixed turret or fighting 'cab' rose. This gave them less climbing ability. The Schneider tank was powered by a 60 h.p. engine, carrying one 75 mm. gun and two machine-guns. The Chamond was larger—25 feet against 19 feet—and armed with two additional machine-guns. It had a 80 h.p. engine with petrol-electric transmission.

The delivery of tanks, as in England, did not take place to time, and by the Spring of 1917 only two hundred and fifty had been completed. They first fought in April, 1917, during Nivelle's offensive, and they failed for very much the same reason as the British tanks, lack of training with infantry or lack of reconnaissance. They did not come up to expectations. The men fought very gallantly; there were individual successes, but results were very inconclusive. All through 1917 the French tanks took part in small actions, the most successful being at La Malmaison, in October. By this time many 'authorities' were ready to 'blow cold' on tanks, and but for the British success at Cambrai in November the programme might have been cut. This battle convinced the French of the possibilities of decisive action by tanks and, in December, orders for four thousand were placed.

Some time before, Colonel Estienne had developed new tactics which it would be possible to put into effect with a light tank, and after some time he persuaded his superiors that the 'Renault'

was an important weapon upon which the French should concentrate. This little tank had a crew of only two, one driver with one to fight, weighed only 6½ tons, and was armed either with a 37 mm. gun or a machine-gun mounted in a small revolving turret. It was faster than the heavy tanks and quickly proved itself in action. During the winter of 1917-18, many hundreds were built, but owing to the German Spring offensives, it was not until 18th July, during the Second Battle of the Marne, that they took part in a real tank battle. The tactics here were those used at Cambrai, and were completely successful, inflicting a defeat on the Germans which was the beginning of the end. The success was emphasized because the XI French Army, where no tanks were used, did not achieve its object. From this date to the end of the war the French tanks took part in numerous attacks on the slowly retreating Germans, the speed and manœuvrability of the light tanks proving of great use.

The war ended before America could bring her own tanks into action, although Americans fought very gallantly in British tanks. The tremendous manufacturing power of the United States was utilized for production, and it was arranged that Liberty engines should be taken to France for putting into tanks which were to be assembled in huge special factories. The Americans, with their genius for large-scale manufacture, would, whatever the other Allies had done, have completely overwhelmed the Germans with tanks in the end. A preliminary figure of one thousand two hundred tanks a month was set. In October, 1918, a small 3½-ton tank of American design reached France; it was the first of an order stated at ten thousand.

The Germans produced very few tanks. Quite apart from failure to realize their importance, they may not have had the necessary materials. Their tanks or, officially, *schutzengrabenvernichtungsautomobil,* were noted for very heavy armour on the sides, but were weak above. The design was not good, and the tanks looked exceedingly clumsy beside even the ponderous Mark IVs, having the appearance of overloaded armoured cars. They weighed 32 tons for a length of 24 feet, and were powerfully engined with two 100 h.p. Daimlers. The tank took nearly a score of men to work it, carrying one 5.7 and six machine-guns. In practice, the Germans actually attained more successes with captured British tanks, partly owing to the confusion caused.

Before leaving the Great War, it should be stated that a very small number of tanks were used in Palestine, but neither the

numbers available nor the nature of the country allowed any real opportunity for decisive action. As always, there were many examples of individual courage and success. By some mistake old tanks intended for the practice ground seem to have been sent out in the first instance, and it is astonishing that they were able to go into action at all. Later, a very small number of Mark IV machines were sent. The light Renaults could have been exceedingly effective, but almost until the close of the Near East campaign the situation in the West remained such that armaments could not be spared. If tanks had been organized at home as well as they were fought abroad, a very different story might have been told.

Chapter Four

BETWEEN TWO WARS

BY the end of the Great War tanks had revolutionized warfare. But the German claim that tanks alone were responsible for their defeat, was an obvious exaggeration. Some excuse was needed for the series of German reverses which began on 18th July, 1918, and tanks offered a convenient explanation. The uncritical public did not perceive that if in fact tanks were all-conquering, their leaders must have been blind not to sacrifice everything to the building of tanks after they had first seen them in action nearly two years before. After 1919 a combination of circumstances resulted in a general apathy towards tanks, which developed soon after the Armistice. Most important, perhaps, was an impression that the Great War had been the 'war to end war'; or that another war in our time was unthinkable.

In the Army itself, perhaps, there was still opposition to all mechanical novelty. Partly unconscious, partly on traditional grounds, it was argued that tanks had been invented to solve the military problem of overcoming entrenched infantry in fortified lines, and that the next war might present no such difficulty. There remained, of course, a number of far-seeing men who realized that the next war would be far more mechanized, and that it might well be a war of tanks in which the few hundreds used in France would seem a trifle. Technically, there was the evidence of the Whippet or Medium A tanks, so effective in open country. Tanks had operated in the deserts of Palestine

and in the difficult terrain of Russia, with General Denikin's forces. A battle under conditions which made the use of any kind of tank impossible would be the exception. Britain and France, having attained a lead in tank design and construction, would be very unwise to sacrifice it to prejudice or Poonah.

The lethargy and conservatism of the many triumphed, for a time, over the imagination of the few. Economy and disarmament was the order of the day. The Tank Corps was drastically reduced to a single 'regiment' of four battalions, no new machines were ordered and, as far as possible, orders already placed were cancelled. The argument of the tank 'enthusiasts,' that, far from being an expensive weapon, it was economical in pounds, shillings, pence and lives, passed unheeded. It was forgotten that the preliminary bombardment of Ypres cost about £15,000,000; the price of two thousand eight hundred tanks; that because a tank transports itself, it is exceedingly economical in man-power; a machine-gun in a tank required 3.1 men, in a machine-gun battalion 32.6 men.

The truth was that the nature of the change in war conditions, or even that a change had occurred, was hardly perceived by the many; while the few who realized the part tanks must play in any future war were faced with a most difficult task. It was clear that the latest tanks would be obsolete before the next major war. Along what lines should a tank be developed? Should the move be towards greater speed and mobility, to an increase in size making an almost invulnerable land battleship, or towards the small light tank relying upon its size and speed to avoid anti-tank defences? Related to this was the place of tanks in strategy and the evolution of new tactics. Finally, there was the question of manufacture; until it was certain in which direction development would take place, what was the use of arranging for mass production? There were already line upon line of tanks rusting away in the tank parks of the training grounds. All this was a matter of high policy depending upon when it was feared that the next war might take place. Mechanized warfare, because of the time required to manufacture the weapons, gives a tremendous advantage to the aggressor, who can arrange that the outbreak of war takes place at the very moment when his own output is at a maximum.

Fortunately, the advantages gained by design and by British genius in craftsmanship were never lost. During the twenty years of peace it is doubtful whether there was ever a period during

which British tank design was not ahead of that of any other nation. But only too often these designs remained on paper. As usual, invention was neglected or referred for action to academic committees.

Britain furnished the war with the Mark V tank which was actually used in the last stages, and the Medium D, an improved 'Whippet' which was to have been used in a 1919 'blitzkreig.' In 1918, Colonel Fuller had conceived the use of tanks in much the same way as they were used by the Germans in 1940. Major E. W. Sheppard[1] admirably sums up the plan thus:

> 'The way the idea was to be worked out was to select a front of about one hundred miles on which obvious preparations for an old-style grand attack were to be made, so as to attract the enemy's attention and induce them to mass large reserves to meet it. Then suddenly, without any warning, a fleet of the new fast 'Medium D' tanks would be launched which would cross the enemy front at top speed and make direct for all their headquarters . . . meanwhile our air force would systematically bomb all road and supply communications intact, so as to allow the alarming reports of the attack, and the confusion expected to result from it, to be as widespread as possible.
>
> 'No sooner had this confusion reached its height than a powerful regular attack, with infantry, artillery and heavy tanks, was to be launched and to press forward and occupy all the zone, extending back some six miles from the front line, in which the bulk of the enemy artillery was in position. As soon as a wide breach to that depth had been effected, a pursuing force, consisting of all available medium tanks, and infantry carried on lorries, was to be thrust through and to push rapidly ahead, sweeping away all centres of communication. . . . It was expected that this pursuing force would be able to advance at the rate of some twenty miles a day, the lorry-borne infantry operating where the tanks could not, and forming a protective line at night to allow the tanks to rest and refit. . . .'

Twenty miles a day was exactly the speed averaged by the Germans in France in 1940.

That is how the war might have been won in 1919; it shows that tank tactics had advanced far from the most revolutionary

[1] In *Tanks in the Next War*.

conception of the enthusiasts of 1916. Such an advance had been made possible by technical progress with tanks. Spring suspension of the wheels inside the caterpillars and hydraulic controls had been introduced, the range of light tanks without refuelling increased to one hundred miles. Speed was increased to 12 m.p.h. and, in one case, to over 20 m.p.h. One point was interesting in view of the 'novelty' of the Russian amphibian tanks in the present war. An amphibian had been designed, and one was completed after the Armistice. It swam rivers and travelled at 28 m.p.h., but the design was not carried forward because of certain technical imperfections, notably difficulties with the steering.

The first four or five years after the Great War were a period of marking time. The tanks 'left over' with which the Tank Corps, the Royal Tank Corps in 1923, was equipped, wore out, the majority of the men who had seen service in them returned to civilian life, and governments became reluctant to spend money. It was plain that new tanks were required. The first to be produced was the Vickers Light tank which was 18 feet long. It weighed 10 tons, being armed with one three-pounder and two machine-guns. Its speed was 20 m.p.h., and its range without refuelling one hundred and fifty miles. This was a considerable improvement on any war-time tank. A novel feature was the elimination of the 'all round' caterpillars, the tracks being carried on a low chassis. The guns and crew were carried in a superstructure. This reduced the climbing power of the tank and it had not the trench-crossing ability of the long Mark V, but, it was reasonably argued, this would not be required in future wars. A further disadvantage found in practice was that the tank was apt to bounce at speed and to render accurate fire difficult.

To gain speed, armour was sacrificed, and it appeared that the first models were not wholly effective even against the ordinary rifle bullet. In later models the armour was increased, but at a slight sacrifice of speed. This, largely for financial reasons, remained the standard tank of the British Army until the arming of Germany seriously alarmed us once more.

Design did not remain quite static, and some models of improved tanks were produced. That which attracted most attention was known as the 'Sixteen-ton tank,' completed about 1928. This was very much faster, and had its guns in turrets. But before production from the prototype could begin the 'economic blizzard,' rendered necessary by peculiar finance, was on us, retrenchment was the order of the day, and it was accompanied

by a disarmament campaign which made tanks unpopular. It was not until 1936 when it become apparent that other countries were arming powerfully, that new designs were sought. Theoretical discussions continued vigorously, but one disadvantage of having only 'shadow' tanks is that no experience can be gained in their handling. The tank crew must have training and experience with the actual type of machine they are to fight. There was the real danger that if war broke out before mass production of the new tanks had been under way for some time the double call of tanks for training and tanks for fighting would be more than could be met.

Meanwhile, there had been some very interesting experiments with 'tankettes,' or one-man tanks. The originator of these was Major G le Q. Martel, who built and experimented with the first models in 1925. His idea was that a large number of small, fast tanks, would be preferable to a few heavy armoured or comparatively slow machines, and that these tankettes would be able to act as scouts or skirmishers to the heavy tanks. In practice it was found that driving and working a gun was more than one man could manage, so the tanks were redesigned for a crew of two. The tankettes had a speed of about 20 m.p.h., and a number were made by the famous Morris firm, use being made, as far as possible, of commercial motor parts so that, in the event of war, rapid expansion of production would be possible.

In 1927 the Carden-Lloyd two-man tankette was produced. Its weight was about two tons, and its speed 21 m.p.h. The cost was only about £500, meaning that thirty or more of these vehicles could be produced for the cost of one heavy tank. At this time it was decided to rename these two-men machines, light tanks, the former light tank becoming a medium. Tank classification has always been a little elastic.

Perhaps the most important innovation was made in the late twenties, when wireless became standard equipment. During the Great War the importance of tanks being able to communicate with headquarters and with each other was recognized, and a number of wireless or signalling tanks formed part of every large force used in the later stages. The solution of the technical difficulty of producing a wireless receiver and transmitter, compact, yet strong enough for any tank was of the greatest importance, for it made it an easy matter for the commander to keep in touch with his base many miles away, or for tanks in battle to communicate with each other. It opened up immense possibilities of

tank-air co-operation which were first fully exploited in the Battle for Poland.

Amongst the experimental tanks made during the years of peace may be mentioned a Carden-Lloyd amphibian, built by Vickers. It was propeller-driven in the water at a speed of six knots and gave a remarkable demonstration in the Thames. It was very light, weighing about $2\frac{3}{4}$ tons and capable of firing when afloat. Other countries, especially Russia, became interested in the amphibian tank, but it was not taken up in Britain; apparently because it did not appear useful to British military strategy, or perhaps because it chanced to be new.

It should be pointed out here that the development of the tank by the various Great Powers followed different lines, less because of the varying ideas of inventors and designers than because of the different needs of their armies. In other words, military experts had to decide where the next war would be fought, deduce the conditions prevailing, and then lay down the type of tank that would be most effective. In the Great War tanks were chiefly 'infantry tanks,' that is, heavy tanks capable of flattening barbed wire, straddling wide trenches and overcoming resistance with the infantry close behind. It was not generally conceived that the next war would take this form, if only because the very speed of modern tanks would make the construction of fortified lines under fire impossible.

British experts did not base their strategy on the idea of an immediate large-scale Continental war, if for no other reason than that there were no large forces available. The whole of the British Army would have seemed trifling behind the masses of the other Great Powers. British tank strategy was primarily based on defence, with 'light' forces carrying out delaying actions to cover the mobilization of another Power. It was conceived, perhaps, that if fighting on the Continent became necessary Britain would again have the role of a 'contemptible little army,' and it was believed that with fine equipment, on however small a scale, the tanks would be worthy of the men. The tendency in Britain for some years, therefore, was towards light tanks, gun carriers or similar vehicles, and it was left to the Continental Powers, with their plans for battle on a vaster scale, to experiment with the huge infantry type.

Unhappily, theory was always far ahead of practice, because Britain had only a solitary tank brigade or, as one author puts it, she had more tank literature than tanks. General Fuller, one

of the names that will always be associated with the tank, 'preached' tanks incessantly in all those lean years. It was largely due to his enthusiasm, foresight and refusal to be discouraged that the idea of tanks was kept so constantly to the fore, even when the machines themselves were lacking. How skilfully he predicted the nature of future tank warfare can be seen from this summary of his ideas given by Major Sheppard, more than a year before the beginning of the present war.

> 'He sees the armies of the future, small, professional, fully mobile, high trained and skilled, divided into two parts with separate yet joint functions. The non-tank arms will form mobile anti-tank forts, supplied by fast-moving armoured convoys from the rear or by air; they will advance into and establish themselves solidly in the hostile territory to serve as jumping off and rallying places for the tank fleets and the air squadrons which will range far afield to seek out and destroy the enemy. Infantry, cavalry, and artillery, all the old arms, all the old mechanism of war as we know it to-day and as our forefathers for centuries back have known it, will henceforth be outworn and demoded. The new model armies, children of the aeroplane and the tank, will wage a new form of war; a war not of lines and positions, but of areas, where attack may be delivered from, and the defence must guard any and every side; from the air above, from front, flank or rear; where nothing is impossible and nothing is too bold to attempt or to achieve.'

And yet there are still people who were surprised by the novel methods of the Germans. The Germans, in fact, seem to have taken their tank strategy and tactics from Britain, where a few original minds were relegated to the background by the usual mass of prejudiced nonentity.

The tendency to experiment, rather than mass produce, in Britain, was encouraged by the variety of theatres of war in which Britain might be involved. Most countries know the land over which any future war involving them will be fought. Britain's widely distributed interests and responsibilities made it necessary to consider warfare in widely different lands or circumstances; on the north-west frontier of India or the fields of Flanders, in the mountains of Kenya and the sands of Egypt. No greater contrast to the rolling downs of Salisbury Plain, on which tank manœuvres often take place in Britain, could be imagined than the Libyan

desert, yet here we have reaped the reward of pre-war experience and experiment. No other nation has developed the possibilities of tank warfare in the desert, first demonstrated before Gaza, to the same degree.

Broadly, there were two ways in which tanks could be employed; as an independent force, striking deep into enemy territory, or as an auxiliary of the infantry, attacking with them on a broad front. According to which conception of tank warfare was adopted, so would construction tend towards speed or armour. In the Great War it was not necessary to construct tanks with speed much above the walking speed of a man, because tanks operated with infantry in close support. Before the end of the war the British had conceived of the tank 'raid' far behind the enemy lines, attacking his headquarters and communications and, as explained, this operation would have been carried out on a considerable scale in 1919.

At first, only the British and the Germans retained this conception of tank warfare. The French, the Russians and the Americans considered the tank purely as an auxiliary of the infantry. They could imagine a war without tanks, but they could not conceive of a war without infantry. Italy, when she began tank construction on a large scale, leaned also towards the tank as an infantry auxiliary. It was, perhaps, a natural tendency for countries with unlimited man-power.

To take the nations one by one: Germany was forbidden by the Treaty of Versailles to build tanks, but her army was quickly practising with dummy tanks made of canvas and wood carried on motor-car chassis. Some of her officers were able to obtain first-hand experience when they were lent as technical experts to Russia. There is reason to believe that before the Nazis came to power actual tank construction was in hand, and it then proceeded, if not openly, with only such secrecy as the Germans wished to preserve for military reasons. As far as tanks were concerned, the Germans had received a first-hand lesson during the Great War. They did not forget it, and early set out to make these weapons the spearhead of their attack. They followed British experiments in mechanized warfare in the late twenties with great attention and learned from them. Their military literature was full of articles about the use of the tank.

During the thirties, they set about building the most formidable force in Europe, and they seem to have deceived the intelligence operators of other countries into underestimating both

the power and number of their tanks. The tendency to underestimate the efficiency of German tanks was encouraged by the breakdown of a number during the 'victory march' into Austria when the tanks had no opposition to overcome. It is now suggested that some of these breakdowns may have been deliberately 'staged' to deceive observers, but it is more probable that they were part of the 'growing pains' of the new force. These German tanks bore no technical relationship to the fifty or so that Germany used during the Great War. Germany, in starting from nothing, lost the doubtful advantage of tradition, but enjoyed the benefit of having no obsolete tanks which a frugal government, and all governments were frugal about armaments during the false economy depression, were reluctant to scrap.

Still more important was the plan of co-operation between tank and aeroplane which Germany developed. This was no new thing. In the major tank attacks of the later part of the Great War the British used aeroplanes to bomb and machine-gun in front of the tanks. The Germans were the unfortunate soldiers cowering from aeroplane attack in their positions until the tanks were on top. This painful lesson was not lost. They brought the joint work of dive-bombers and tanks to a high pitch. Little troubled by tank lore, they learned from other nations and developed every hint. They developed what seemed to the orthodox, a highly adventurous strategy and tactics.

In Spain, German tanks did not prove particularly effective, but there is reason to believe that neither Russia, Italy nor Germany disclosed everything in Spain. It was a testing ground on a small scale. The chief fault of the German tanks seemed to be that they were too lightly armoured; they would have suffered more if the Nationalists had possessed sufficient anti-tank guns and artillery.

In France, as in Great Britain, little was done in the years immediately following the war to construct new tanks, but a certain amount of technical experimental work was carried out. The 8-ton Renault remained their main armament until the thirties, and amongst those in power there was no encouragement of the idea that the tank could operate independently of the infantry. France's whole outlook was defensive, and this greatly influenced her tank construction. It would be impossible here to enter into details of French military strategy which decided the form of her mechanization. War experience showed it was faulty in both principle and practice. The French were reputed to have

developed a tank weighing 68 tons, with very thick armour, two field guns, two machine-guns and a speed of 20 m.p.h.

At the end of the Great War, the United States had the Mark VIII, or 'Allied' tank. This used the famous Liberty aero engine, but was otherwise based on the latest British practice. It remained the standard heavy equipment for many years. The United States had also constructed a factory for the manufacture of the Renault tank. None were completed in time for use in the war, but they served the United States for the first years of peace, after which they were supplanted by a light tank with a speed of 18 m.p.h., a range of eighty miles and a crew of two. The armament was one 37-mm. gun and one machine-gun.

Later they developed powerful 'combat cars.' These were turreted machines using an aeroplane-type engine in the rear with cylinders in a circle round the driving shaft. The caterpillars were rubber coated and the vehicles credited with a speed of 55 m.p.h. Armament was formidable: a .5 turret-gun used with a small calibre machine-gun, a .3 anti-aircraft machine-gun and a .3 cowl machine-gun. The United States is the most 'motor-minded' nation in the world; that tank construction did not keep pace with Europe can only be explained by the apparent improbability of war.

A year before the outbreak of war in Europe, the U.S.A.'s seventh cavalry brigade carried out a spectacular journey of seven hundred and fifty miles to manœuvres, averaging one hundred and fifty miles a day, with the six hundred and forty-eight vehicles which varied from tanks to motor-cycles; a small armoured column. The march was not a demonstration of America's might; until recently her tank force was no greater than that of a third-class Power, but of the enormous technical progress in armoured vehicles that had been made since the Great War. A journey of this length in 1918 would have been made by loading the vehicles on to railway trucks, they could not have stood up to the wear and tear. This march, carried out more or less under service conditions, repair units travelling with the force, and positions kept by wireless, demonstrated better than the periodical tank parades of the totalitarian countries the reliability of the modern internal combustion engine. At the outbreak of the present war the United States had few modern tanks, but she has since produced several new types which are described later, and with her unique manufacturing capacity could, if she wished, make herself the most powerfully armed force in the world.

Russia's tank force was the enigma of pre-war days. During the Great War Russia had no tanks, her resistance was broken before the Allies could supply her. But her soldiers met tanks in the wars of intervention so that when peace came she received considerable assistance from German experts and technicians who were denied opportunities of experiment in their own country. As the gigantic plans for converting Russia into an industrial nation were revealed it became apparent that her new armies would be heavily mechanized to include a very large force of tanks. Those who had reason to underrate the country for financial or similar purposes found consolation in the notorious inefficiency of Russian mechanics of pre-Great War days. This attitude persisted, even amongst some English experts, even after the outbreak of the Russo-German war. They overlooked the changes that had been brought about in Russia. Whereas the country was pre-eminently agricultural, it was turning more and more to industry. Moreover, agriculture was mechanized to a remarkable degree and this provided a flow of mechanics to the army in addition to making the ordinary man more 'machine minded.' Russia has reputedly 3,000,000 tractor drivers and about 500,000 tractors. Tank driving became a 'hobby.' In 1938, no less than 1,000,000 members of the Association for Improvement of Aviation and Chemical Defence had passed tank and ambulance driving tests.

This was the background to the building of a huge tank force from nothing. Before the war, Germany estimated this force at twenty thousand machines, an interesting comparison with the five hundred used by the Allies at the successful Battle of Cambrai, but not such an astonishing number when we remember that the Allies planned to have thirty thousand tanks if the war continued through 1919. Not only the numbers, but also the quality of Russian tanks were generally held to be exaggerated. It was stated that Russia had no talent in engineering design, that her tanks were mere copies and the steel poor. Yet in Spain, that testing ground of modern armaments, the Russian tanks, and the Spanish-built copies, proved the most effective of those used. Only light and medium tanks were sent to Spain, but they were better armed and armoured than the German or Italian tanks. Their greatest weakness was underneath; 'their stomachs are not better protected than a hedgehog's,' as the Spaniards put it, and this, perhaps, explains the success enjoyed in attacking them with petrol. There is reason to believe that later types were improved from this point

of view. Russia had further first-hand experience against the Japanese in a short but sharp campaign in the Far East, and the Japanese gained a considerable respect for these tanks. The Finnish war, mentioned in the following pages, again deceived the critics of Russia's tanks.

Russia's huge industrial resources, so largely devoted to armaments in recent years, have enabled her to experiment on a large-scale, and she has done this both in machines and tactics. Essentially, her tanks are intended for use with infantry. Fifty tanks to a division were allotted before the present war, but the number was increased as a result of experience in the campaigns of Poland and France. The Russians specialized in very heavy tanks. As far back as 1936 they had over one thousand tanks of more than 30 tons. It is believed that their heaviest tanks are now in the region of 100 tons, carrying an armament of a 6-inch howitzer, two light field guns, two heavy machine-guns, and two A.A. machine-guns. But they also developed 'one man' tanks armed with a single machine-gun, amphibian tanks and air-borne tanks. The latter are said to be of about four tons. 'Experiment' has always been the keynote of Russian tank experts. In the Finnish campaign they produced armoured sledges to carry infantry behind the tanks, and used tanks to tow infantry on skis. They believed that tanks were the best defence against tanks, because they alone provide the mobile fire-power necessary. They believed an anti-tank gun good, but an anti-tank gun on a tank even better. The huge sums that France expended on building the 'impregnable' Maginot Line, Russia spent on building what was, probably, the most heavily armoured force in the world before the war. The very immobility of the Maginot Line proved the reason for its downfall.

The Russians showed themselves great experimenters both in material and in tactics. Few other nations would take their novelties very seriously. In 1937, 'paratroops' were dismissed as a stunt; 'plane-carrying tanks were an amusing novelty; the tactics to be employed in tank and aircraft co-operation went unheeded, except by the Germans. The widespread depreciation of Russia's forces was really remarkable, for experts who returned were often full of their praise. General Martel, for instance, wrote: 'The tank leadership I saw at the manœuvres can only be described as brilliant.' Moreover, in the only war in which Russia was engaged, against Japan in the Far East, her tanks came out very well, and although it was little more than an 'incident' by the standard of

modern wars, the Japanese admitted eighteen thousand casualties on the only occasion when the armies met in some force.

When Italy began to re-arm, considerable numbers of light and heavy tanks were built. They were primarily intended to co-operate with infantry. Abyssinia presented few opportunities for the use of tanks, but the Italian light tanks did considerable service, although they were not very effective across country, and tanks confined to roads lose much of their value. In Spain, the Italian tanks proved insufficiently armoured, and would have suffered even more heavily if the Nationalists had been better provided with anti-tank guns or artillery. On the whole, the Italians seem to have sacrificed too much to speed, and in Libya their tanks showed themselves no match for ours. Italy is not a rich country and her tank 'peak' was probably reached some years ago, so that the types she had available at the outbreak of war may not have been so well advanced as those of other Powers. It had not then been fully demonstrated that munitions of war depend upon far more than money for their construction.

Summing up briefly the twenty years of tank development between the two wars, we can say that, although it had been spasmodic, tremendous technical progress had been made. The speed, range, and protection of the tank had increased enormously. Most important, reliability and resistance to wear, had increased. The breakdown for mechanical reasons was the exception but not the rule although the tactical employment of tanks had not, in many cases, advanced with their technical improvement. The rate of the German advances in Poland or France seemed 'incredible'. Examined coldly in the light of the known performances of tanks in 1939, there was nothing astonishing, given the power to overcome frontier anti-tank defences and the undoubted fact that tank speeds have vastly improved.

Max Werner estimates the total tank forces of the European Great Powers at the outbreak of the war as twenty-five thousand. On this basis by far the largest force was in Soviet Russia, and the number of tanks possessed by this power was put in some quarters as high as twenty thousand. Britain had only a few hundred, France perhaps three or four thousand, Germany an unknown number, but possibly four thousand as a result of the acquisition of the Czech tank force which was one thousand five hundred strong. Italy had a tank force of about two thousand, but this was divided between Italy, Libya and East Africa. Shortly before the Munich crisis an estimate of the numbers of tanks possessed by

BRITISH CONVOY ON THE JENIN-NABLUS ROAD, PALESTINE

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BRITISH INVASION BARGES OF A TYPE SIMILAR TO THOSE EMPLOYED FOR THE LOFOTEN ISLANDS NORWAY

the great powers was given in a professional journal as follows: Britain, three hundred and fifty; Germany, two thousand three hundred; France, three thousand; the Soviet, three to four thousand. Germany may have had many more; the figures quoted can well have been suitably varied for what is euphemistically termed 'political reasons.'

Chapter Five

TANKS IN THE SECOND WORLD WAR

WHEN the second World War broke out, opinion was uncertain as to the real value of the tank, how effective it would prove in practice against the defences which had held its advance and the anti-tank guns which had knocked it out with such certainty at manœuvres. Even after Poland, the part of the tank does not seem to have been realized; except by the Germans and possibly the Russians. Two months after Poland we find a so-called expert writing: 'the tank does, in fact, remain to be proved. . . . Perhaps it is the most effective weapon we possess. On the other hand, perhaps it is a big white elephant.' Only a few months later it was to be shown that even big white elephants, used in sufficient numbers and with the correct tactics were as effective as they had been centuries ago when Hannibal used them (the colour was immaterial) as one of the forerunners in principle of the tank.

Even to illustrate these points it would be impossible to give an account of every tank battle in the present war. History has been made so rapidly that we are apt to forget the details of events occurring only a few months ago. But many battles are still fresh in the memory and we can be content with a brief account of the work of tanks in the major campaigns or the conclusions to be drawn from them. Many matters of great interest must, unfortunately, remain secret and unpublished until after the war.

Hostilities opened with the German invasion of Poland. This was not primarily a tank campaign, for although the Germans used their tanks or armoured columns to pave the way to every vital victory, the Polish army had few tanks and inadequate anti-tank defences. They are generally agreed to have weakened their forces by their original dispositions and anxiety not to sacrifice ground. 'Defence in depth' had been developed in the Great War and was practised by all armies, but the immense depth necessary

in dealing with powerful and fast armoured forces was not appreciated in practice.

The Germans launched against Poland six armoured divisions, ten mechanized and motorized divisions and forty-five infantry divisions. Poland had, although not fully mobilized and not equal to the German divisions in fire-power, an equal number of infantry divisions, but only six battalions of light tanks or armoured cars. The German plan was, by a series of rapid and powerful thrusts, to surround and annihilate the Polish armies; in this plan they were helped to a degree by the original Polish dispositions. Everywhere the German armoured and mobile divisions were in the fore, cutting a way through the opposition and making thrusts the depth of which seemed dangerous according to the ancient principle of war that the flanks must be protected. Into these gaps poured the infantry.

In the northern area, General von Bock had one armoured division and one motorized division in East Prussia, another motorized division lay in Pomerania. There were three armoured divisions in the centre, near Breslau, under General Guderian, and two in Slovakia. The three armoured divisions in the centre quickly overran the frontier defences on the opening day, immediately rushing along the main road to Pistrkow and Warsaw. This force covered ground at remarkable speed and by 8th September, a week later, one part under Gen. Reinhardt was only twenty miles from Warsaw. This led to a premature announcement that the capital had fallen, but, in fact, the whole city turned out, while barricades and offensive action forced the tanks to retire.

Very little later, the armoured forces from East Prussia threatened Warsaw from the north-east, but after crossing the Narev and the Bug, one part was badly cut up by artillery, the best part of a division being put out of action. Other divisions then made a wide encircling movement and reached Brest-Litovsk. Here they met the advance guard of the mechanized divisions which had advanced from Silesia, so that the whole of the Polish armies west of the Bug were virtually encircled and trapped. This was on 17th September, and whatever hopes the Poles may have had of continuing resistance to the east was dashed by the entry of the Russians into Poland.

The whole campaign was virtually over in seventeen days, operations after that time being confined to reducing strong points and 'mopping up.' The Germans claimed 694,000 prisoners, for their own losses of 33,000 killed, wounded and missing. Even

doubling this latter figure, it was perhaps the most astonishing campaign in modern history and was to remain so until the British actions in Abyssinia or Libya, where Italian armies totalling 500,000 were destroyed by one-tenth or less of their number.

In Poland the Germans enjoyed complete air supremacy. Poland's air force was small but well manned; it had little chance to get into action, for on the opening days the air fields were so effectively bombed that very few 'planes were able to take off and many crashed on landing. Germany did not, in this campaign, use her bombers extensively in close co-operation with tanks, but her supremacy in the air meant that Poland's armies were blinded, whereas her own were aware of the enemy's every move.

The campaign was followed by a spate of literature and some of it makes grim reading to-day, for very few experts and critics seem to have learned the simplest lesson. Much of it was designed to show that 'it couldn't happen on the western front,' that tanks would be quite unable to carry out these huge encirclements and deep thrusts in the face of anti-tank guns or opposing aircraft, that it was only the dry summer that had given the Germans victory. In fact, every conclusion seems to have been drawn except that which was right: that here was a kind of warfare which, if not new since it had been predicted by a number of men, could be studied in action for the first time. Yet what did we read? Here is a typical quotation: 'All foreign eye-witnesses of the fighting agreed that wherever the Poles had not to contend with tanks, armoured cars and aircraft, they proved better than the German infantry.' And more than twenty years had passed since Mr. Churchill had written of 'generals fighting machine-guns with the breasts of gallant men.' The statement was perfectly true. The Poles fought with tremendous courage, but the obvious truth that courage and rifles are not enough was not brought home to the public. The real lesson of the campaign, as far as the tank was concerned, could have been grasped from minor incidents. When Reinhardt's force, which thought it had taken Warsaw, for example, had to retreat, its petrol and ammunition gave out; it could have been annihilated if the position had been appreciated. A powerful German tank formation at Czenstochowa was badly cut up by a small number of Polish 'planes which did get into the air, and another successful air attack was made a fortnight later. A Panzer division, when parked, was attacked by infantry and narrowly escaped. These three incidents could have taught three ways in which a tank column can be tackled.

The astonishing power of armoured divisions to sustain themselves was not fully appreciated by foreign observers. In many cases they were seventy or eighty miles in front of their infantry. One column did an astonishing 'circular tour,' remaining out of touch with its infantry for a whole week. Here, in practice, was the doctrine of tank warfare advocated by General Fuller shortly after the Great War and all through the years of peace. It was appreciated by very few, and the vital fact, that it demanded mechanical superiority from the outset, went unnoticed. Certainly it did not result in what should have been the obvious sequel: to spend the winter building tanks, tanks and more tanks.

The Germans used no very large machines in this campaign. They seem to have been mostly tanks of eight and twelve tons, powerful enough for their purpose. They kept in reserve or spent the winter constructing very much more powerful weapons so that in the spring they would again have this mechanical superiority on the Western Front. Here there had been only minor fighting; the French losses in men on land, at sea and in the air during the first three months of war were one thousand three hundred. Where French tanks had come in contact with the enemy, they had proved good, but there had been nothing more than very light engagements in the 'No Man's Land' that divided the two great fortified lines on the Rhine frontier. The British army spent the winter fortifying the Belgian frontier, carrying field defences from the Maginot Line to the sea. They had gone to France with twenty-five thousand vehicles, the House of Commons was told and the contrast was made with 1914 when a far less number were employed.

While through the winter of 1939-40, tanks on the Western Front remained under their camouflage or practised well behind the lines, another war broke out in the north which was to show the decisive power of the tank in a method completely contrasted to that of Poland. This was the Russo-Finnish campaign. In the early stages, the Russian tanks fared badly and those who did not believe in tanks congratulated themselves on their forecast that first-class infantry would always be able to deal with 'machinery.' The Russians failed in the early stages of the war for many reasons: they used troops from the south, ill-equipped to fight at below zero temperatures in a land of forests and snow. They could not ski. The tanks keep mostly to the roads, which often had deep snow-filled ditches at the side to make natural traps.

These conditions did not help the Russians to benefit from

their greater numbers and ample material, while the Finns showed themselves excellent, intelligent fighters against tanks in limited numbers under Arctic conditions. In many cases the temperatures were such that oil was frozen. Twenty or thirty degrees below zero is not a temperature in which tanks, unless specially equipped, can be expected to work properly. Small tank units found their communications cut by the mobile Finnish patrols. One of them, the 34th Tank Regiment was surrounded, and, while waiting for relief, formed a stockade of the tanks. In this they were beseiged for fifty-four days during which they received no food or ammunition. The camp was finally assaulted, but it had taken very heavy toll of its attackers for nearly two months. There should have been a lesson here for the Germans, if they were even then contemplating attack on Russia.

The Russian High Command, after a series of minor defeats and set-backs all along the front, decided on the direct assault of the Mannerheim Line, a typical example of post-war fortification, very skilfully carried out. Conditions were much nearer those on the Western Front during the Great War and the Russians showed how 'blitzkrieg' could be carried out in a war of fixed fronts as well as by a war of movement such as there had been in Poland. The Mannerheim Line was taken by a series of sustained assaults, carried out by all arms in co-operation: aircraft, tanks, artillery and infantry. The reorganization of the Russian tank forces showed that they were placing more reliance on the heavy tanks; they used numerous 33-ton models as well as tanks pulling armoured sledges full of infantrymen. For this attack the Russians used no light tanks, a total of about one thousand tanks being used.

There was a terrific preliminary bombardment designed to overturn the Finnish concrete fortifications by loosening the earth under them so that they would tilt and prevent the guns from bearing. With heavy tanks, followed by medium tanks pulling armoured sledges making journey after journey across No Man's Land to bring Russian infantry to the edge of the Finnish trenches, the Russians eventually made a small breach in the line. They poured in their tanks and sustained the offensive day after day in spite of heroic defence by the Finns. Pioneers brought up by the tanks were used to blast anti-tank traps or obstructions and to remove mines. Finally, the Russians made the Finnish defeat certain, even if they could retreat to a second line, by a bold advance with tanks over the ice from an island in the Gulf of Finland. These tanks travelled seventy miles across the frozen sea in spite of efforts

to stop them by bombing the ice in front. The movement completely turned the Finnish right flank.

The lesson of Finland, like that of Poland, went almost unheeded. It was that modern fortified lines with all their tank obstructions (the Finns made great use of granite blocks, guns and mines) could be breached by tanks used in sufficient numbers. It merely required 'blitzkrieg' tactics, that is a heavy sustained assault by all arms. Foolishly enough many people, remembering the unfortunate experiences of the Russian tanks during the early stages of the war, drew the conclusion that they were ineffective, forgetting that in a month they had breached a line which was thought to be impregnable because its narrow front permitted only a limited number of men to attack it at one time.

The Battles of Flanders and France, although they lasted a comparatively short time, were tremendous affairs in which about two hundred divisions of men were involved. Books have been written about these battles of May and June, 1940; no doubt many more will appear. At present we must content ourselves with a very brief description and a few of the more obvious deductions.

From the German point of view the campaign in the west passed through three phases: an assault of the frontier fortifications, a war of movement, and the final encirclement or annihilation of the forces opposed. In the first phase tanks and armoured divisions were not used. They were held back to take immediate advantage of a breach in the fortifications made by the shock troops, pioneers and, above all, perhaps, the dive-bombers. The forts in Holland and Belgium were too powerful to be broken by tanks. They, like the Maginot Line a month later, were taken by audacious, well-rehearsed assaults with specialized infantry and by incessant dive-bombing. Dive-bombing cleared the way for the Panzer columns which were everywhere the spearhead of the second phase.

In the Netherlands and Belgium, German tanks did not, in general, meet serious opposition, for the break-through in France and the surrender of the Belgians quickly put the British and French forces, inferior in numbers or equipment, in an impossible position with no alternative but withdrawal. The Germans had also surprises: 60-ton tanks and very numerous anti-tank guns. In fact, the British tanks stood up remarkably well to these guns and it is reported that not one was 'holed,' although, of course, they were knocked out by damaged caterpillars. A continuous series of rearguard actions offer tanks very little opportunity to

exploit their great asset of mobility. They can hold up the enemy for hours, but the tank is not designed to fight 'going backwards.' It was the same during the great retreat of March, 1918. Only if the tanks are in sufficient numbers to stem a retreat by sustained counter-attack, can they be fully exploited. This certainly was not the case in Flanders.

Thus, although the British armoured forces fought most gallantly during the gradual withdrawal to Dunkirk, as the Army awards testify, they were not able to meet the Germans in sustained battle or upon anything approaching equal terms. The Germans were reputed to be using tanks of seventy to one hundred tons in France, but there is no official evidence that this was so. The heaviest tank seems to have been the PZKW6, with armour about two and a half inches thick; and a formidable armament of two field guns, a 44-mm. anti-tank gun and a machine-gun. Eight men are required to man it in action. No claim to have knocked out one of these tanks was ever made in France. An interesting point perhaps is that the German tank gunner is apparently trained only to fire from a stationary position.

The type of action in which our tanks were engaged is illustrated by the following examples. Outside Arras, there was a gap left by the French. All the available tanks were ordered to try and close it immediately. Seven heavy and thirty light tanks engaged the enemy and held off very much superior forces for many hours, out-manœuvring their opponents. When finally the order to retire was given, all the heavy tanks and several light types had been lost. Again, when the Belgians surrendered, the 12th Lancers with the 3rd Division closed one of the gaps left, armoured vehicles covering the engineers while they demolished all bridges. At Dixmude and at Nieuport, squadrons of this regiment fought heroic actions which held off the enemy and made possible the evacuation at Dunkirk.

The Germans may be 'businesslike' in some ways, they choose a Panzer tank crew from one blood group to make transfusion easier, but they had not all the good fortune in other ways. In one particular instance, when making their sweep round the Channel ports in 1940, the French were asked to attack northwards to link up with the 50th Northumbrian Division. This order was altered by the French secret radio. Maj.-General Martel, now British Tank Chief, asked for the Brigade of Tanks to help the 50th. The final action was a triumph for 'Slosher' Martel for dozens of German tanks were set on fire and six hundred prisoners were

taken. By this brilliant achievement the 50th Division broke eight miles of enemy territory, it being the first instance of the routing of a Panzer advance.

How the German Panzer divisions created a dent in the French line at its weakest point, widened the dent, then poured through the gap in a race for the sea so as to encircle the British and French armies in Flanders or the Low Countries, is such recent history that it needs no repetition. The Panzers crossed the bridges of the Meuse which were not destroyed, "as a result of incredible mistakes," in the words of M. Reynaud. They then broke the defences, again pressing through between Cambrai and Peronne to reach the coast at Abbeville in the incredibly short time of three days. Here they turned north towards Calais, where the British Army was preparing to evacuate. But the Panzer divisions allowed themselves to be delayed by the magnificent defence of Calais. This delay was fatal to their hopes of destroying the British Army. It gave time for inundations south of Dunkirk to make the land impassable, although if they had taken the opportunity, the tanks might have crossed the shallow water before it had softened the earth. The Panzers had to wait while the British embarked only a few miles away. Altogether, this raid, for it was really no more, covered three hundred miles at an average speed of twenty miles a day. At the end, when disorganization was complete, its speed was doubled. It was like one of the great cavalry raids of the past, but with the added speed, fire-power and, above all, perhaps, the panic and terror-spreading power that machinery afforded. It is said that an important town was 'taken' by only six German motor cyclists. The Germans made very free use of these motor cyclists for every purpose from sheer terrorization to normal reconnaissance.

In the third phase of the battle, which lasted from the British evacuation at Dunkirk until the collapse of France, the Panzers were engaged in annihilating their enemies by using their mechanized forces as the head of a series of great encircling movements in the course of which nine-tenths of the great French Army was taken prisoner or put to flight.

It was a very remarkable achievement, largely due to the seven thousand five hundred tanks and seven thousand or more aeroplanes which worked in close co-operation; but, as Russian and American expert observers noted at the time, the defeat was due to the weakness of the Allies rather than the strength of the Germans. The German armoured columns gambled on this

weakness; or perhaps they knew it already. The Belgian and Dutch armies were almost completely without tanks, the British and French were outnumbered; the French tanks, technically, were disappointing. If the Allies had had anything approaching equal strength they could have done what the Russians did when the Germans used the same strategy; closed in behind the tanks and surrounded them completely. The Allies had banked on a war of positions between fortified lines in which they could have held their better equipped enemy. The Germans by breaking through with their tanks were able to force a war of movement in which their material superiority was overwhelming.

We learned much from the disaster, probably the greatest defeat in military history. We learned that modern tanks could be brought up to fight effectively in very 'difficult' country. The break through was made at the most weakly defended spot, weakly defended because it was believed that it could not effectively be attacked. We learned that there is a flaw in the generally accepted principle that 'tanks can take, but cannot occupy.' The Germans used motor-cyclists as 'occupying infantry.' We learned the importance of denying the enemy petrol or food; the Panzer columns were able to fill up at civilian petrol pumps and take food from dumps and shops. We learned that tanks could co-operate with aircraft, not only at a distance, as in Poland, but more closely, the aircraft acting virtually as mobile artillery, protecting the flanks of the advancing column and making it difficult to organize an attack on these flanks. But we learned most of all. perhaps, the lesson we taught the Germans in the Great War and forgot ourselves, that the 'breasts of brave men are a gallant but ineffective substitute for machines and armour.' Someone was grossly to blame.

The next important fighting took place in the western desert as a result of Italy's entry into the war. Very soon after the Flanders campaign there was sporadic fighting on the Egyptian frontier. We were so full of the disasters on the continent that we hardly noticed encouraging news from this front, encouraging because it showed the dash and skill of British armoured units in offensive operation. In June, a patrol of two armoured cars attacked twenty Italian lorries which were being convoyed by numerous light tanks. After hitting at the lorries, the two armoured cars found themselves fighting twelve tanks, put two out of action and made off. The tanks pursued, but British tanks appeared and, with their great speed, were able to force battle on

the Italian tanks which had turned away. The Italians brought a battery of four guns into play, but the British tanks circled them and killed the gun crews. The armoured cars then took up the chase of the Italian lorries and destroyed a total of seven. Ten Italian tanks had been broken and one captured. It was a brilliant if, considering the scale of the war, a minor action. But it was a foretaste of things to come and should have warned the Italians of the great skill of the British units in the desert warfare for which they had trained for years, and of the superiority of British armed vehicles.

At the beginning of December, 1940, it became obvious that something was afoot in the Egyptian desert, where British and Italian forces had faced each other since June, when the Italians had made a slight advance. The first news that British forces had performed the remarkable feat of crossing seventy-five miles of desert undetected by the Italians was given by Mr. Churchill, and since it was necessary to keep the Italians in the dark, it was not for some days that the pattern or extent of the attack became apparent. Indeed, it is not clear even now whether the full-scale attack with unlimited objectives was planned or was decided upon following the brilliant success of the initial battle.

The capture and encirclement of Sidi Barrani, where three divisions of Italians were destroyed, was the result of a British armoured force brushing aside resistance and taking the position in the rear, establishing itself across the coastal road that might have offered a line of retreat when the frontal attack was made. Such was to be the scheme for the work of the armoured forces in this campaign, although tanks also led the infantry in frontal assaults.

The British armoured forces enjoyed comparative immunity from attack from the air owing to the supremacy established by the R.A.F., but the Italians had large numbers of tanks in Libya, perhaps outnumbering our own. In an early stage of the campaign the Italians announced that Graziani had thrown in a thousand motorized units in an effort to prevent a rout. The Italian armoured vehicles were inferior, and their crews did not show the same initiative and skill as those of British tanks. The enemy were beaten whenever encountered.

The series of encircling movements was carried out against one position after another. The British columns enjoyed the advantage of having the sea on their right flank, and the Navy added further to the discomfiture of the Italians by bombarding

vital points within reach. Bardia and Tobruk were carried by bold encircling movements, led by the armoured forces. The astonishing fact that after a week's hard fighting in which more than 30,000 Italians had been taken prisoner the British forces had lost only 72 killed and 738 wounded was then revealed, emphasizing the point of this new type of warfare that an important victory could be won at relatively low cost in life. Such success would have been out of the question but for the part of the tanks in making initial penetration of the heavily fortified camps and in destroying the forts. The very smallness of our losses, indeed, may have led to an underestimate of the tremendous efforts made by the advancing army.

The Italians put up a strong resistance in every case, until surrounded; they were in possession of huge dumps of munitions, petrol, food and material of every kind, in preparation for the intended advance. It might be pointed out that if they had adopted the 'scorched earth' tactics of the Russians, an advance might not have been possible. Certainly it would not have been so fast, for supplies for British troops and armoured units had to be brought over immense distances. In this, of course, the Navy was able to help, but considerable use was made of petrol and supplies captured. Hundreds of Italian lorries were impressed into British service.

It is impossible to enter into every detail of the fighting. In the taking of Bardia, for example, a very well fortified and defended town or camp, the armoured forces were used in two ways. Tanks led the infantry advance, in a fashion not very different from that developed in the Great War, destroying wire and machine-gun nests. But armoured forces in other positions also used infiltering tactics, throwing the enemy into confusion when they found themselves attacked from the flanks and even from the rear. Bardia resisted for three weeks and when the respective forces of the British and Italians became known, it is astonishing that it fell, for the Italians had numerical superiority in defensive positions including a mechanized division of tanks, armoured vehicles and anti-tank guns. The assault of Tobruk, another stronghold, was carried out in much the same manner. In each case, armoured forces did not wait for the final surrender of the strongly fortified areas, but pushed forty to seventy miles ahead.

The final advance to Benghazi was made at the rate of sixty miles in forty-eight hours, ending a week in which one hundred

and eighty miles had been covered—a tremendous speed when the difficulties of climate are rememberd. To hem in the Italians at Benghazi some of the British armoured forces covered one hundred and fifty miles in thirty hours, completely surprising the retreating Italians. They attempted to break through the cordon, but after sixty Italian tanks had been destroyed, they surrendered. At this point, when the campaign virtually ended, the British had covered four hundred and fifty miles in fifty-seven days and were six hundred miles from their main base at Alexandria.

More important than the occupation of a great area of territory was the capture or destruction of so many thousands of Italians. The tanks had shown that although they could not take prisoners, they could hand them over 'ready made' to following infantry. One of the secrets of British success in this desert warfare has undoubtedly been that of reconnaissance, carried out by men who understand the country. Britain is fortunate in having men who have studied deserts and travelled them for years, making scientific observations on the behaviour of sands and tracks. It was knowledge gained in this way that enabled British tanks to cross dunes which the Italians thought were a natural anti-tank barrier before the attack on Sidi Barrani; it allowed for a first attack from an unexpected quarter. This, incidentally, is another example of the danger of supposing that any natural or man-made barrier can keep out tanks with any certainty.

The Germans, in the Spring of this year, were credited with having expanded their armoured divisions from ten in France to fifteen, in addition to having made good their losses of material. This was a considerable achievement, even if extensive use was made of tanks captured in France.

In the Balkans, German tanks and armoured units were again triumphant. It was a triumph of numbers. Our Allies, the Yugo-Slavs and the Greeks, had only small tank forces and a limited number of anti-tank guns. Because of our commitments elsewhere, we were experiencing a major attack by German armoured divisions in Libya and were engaged with large Italian forces in Abyssinia, we could not land a large force in Greece. Above all, the overwhelming number of aircraft the Germans were able to use in close co-operation with their armoured columns proved decisive. But we soon found out something else besides our need for tanks. We found that the German tanks were by no means invulnerable to anti-tank guns. Hundreds were knocked out. In one action two Serbian battalions with four anti-tank guns

destroyed twenty tanks out of one hundred and seventy in a first attack, and twenty-four in the second. The Germans were apparently willing to suffer these huge losses as long as some of the tanks got through and could work to the rear. The German tanks were employed in masses of two and three hundred at a time in half a dozen places simultaneously, and we were able to realize the astonishing number of tanks they must have built and manned during the winter when we knew that substantial numbers were not thrown into the campaign but were kept on the Russian frontier. We learned that even such difficult country as is presented by the Balkans does not hold up modern tanks; that mountainous country and river crossings were not the obstacles to modern mechanized forces that seemed so serious even twenty years ago.

The most heartening factor of all, perhaps, was the great success of the more powerful anti-tank guns and shells we had prepared as a result of experience in Flanders. There were instances of our armour-piercing shells going right through one German tank and penetrating the armour of another behind it, to explode inside. The Germans used dive-bombers even more extensively than in the Battle of France. It was good to find that tanks were, to a certain extent, able to defend themselves, while the armoured units found Bren guns with anti-aircraft mountings exceedingly effective against aerial attack.

Simultaneously with the Balkan assault, the Germans, who had managed to bring a whole armoured division to Tripoli, launched an assault on Benghazi. General Wavell's strategy, with forces depleted for the campaigns in Greece and East Africa, was an orderly withdrawal, leaving harassing forces to cover the retreat until such time as the enemy's communications were strung across the desert. 'The desert holds no petrol,' and the conquest of desert can prove embarrassing. Much was made of the fact that we lost Cyrenaica to German tanks even more quickly than we took it with our own. But there was a fundamental difference in the actions. In the course of crossing the Italian colony, our tanks and infantry destroyed huge Italian forces, taking immense quantities of material. In reconquering it, the Germans and Italians succeeded in none of the encircling operations, except in the case of Tobruk where, it seems, they 'caught a tartar,' for this garrison not only holds out, but has harassed the enemy rear and made attempts to advance further into Egypt exceedingly difficult. German tanks made numerous assaults on Tobruk, but without success.

One interesting point arose from this reconquest of Cyrenaica by tanks. It had been held that for really effective tank victories, command of the air was essential. During the German advance, the British had a real command of the air, yet it was not sufficient alone to stop the Germans. Tobruk, with its back to the sea and the enemy on every other side, has shown an astonishing ability to deal with tanks which more than once have penetrated the perimeter. Incidentally, the German tanks here used a new weapon for the first time, special flame-throwing cars which were towed behind. These proved themselves very vulnerable to artillery fire.

There seems no doubt that British tank crews have mastered the desert conditions much better than either the Italians or the Germans. The Germans indeed have been stated to have been unable to stand the conditions of summer in the desert. Dust storms, flies, heat, shortage of water—these commonplaces of the desert are trying enough to infantry, doubling trying to men working inside steel boxes. And yet the tanks have actually taken advantage of them and gained surprises by advancing in dust conditions which sent the Italians to earth. The attack on Sidi Barrani after the Germans had established themselves was made in a terrific dust storm, which had prostrated the Germans in spite of their reported training in hot houses in Germany.

The biggest tank battles of all time are now being fought in Western Russia. How many thousands of tanks have been thrown in by both sides we shall not know until the end of the war, but it is certain that enormous numbers have met. The fundamental fact which emerges is that for the first time the German Panzer divisions, used in greater numbers than ever before, have been held. The speed of modern warfare is such that much may happen in a very few weeks, but the fact will remain that two tremendous attacks by armoured forces were unable to break the Russian resistance as they had broken the defences of other armies. The Russians had studied German tank strategy and had devised a means of countering its power. Briefly, this involved (1), letting the tanks break through if they could not be held, but closing the gap behind them and preventing the infantry following up; (2), concentrating the whole strength of the air force on attacking the tanks; (3), where retreat became necessary, destroying everything that might be of the slightest use to the enemy; the scorched earth policy designed to starve the tanks.

The result of (1) has been battles of tremendous depth. There

seems little doubt that German armoured units, advancing many miles, frequently reported that they had taken a certain spot when they were themselves surrounded. It involves great courage and tenacity not only in the soldiers but also for the citizens. The German tanks have been unable to panic the Russians as they did the French. (2) Tanks have shown themselves vulnerable to attack from the air. Especially when the accompanying vehicles with supplies and petrol have been destroyed. This is tactical bombing compared with the strategic bombing of centres of communication far behind the enemy lines in which the British and French air forces employed much of their limited strength during the Battle of France. (3) The destruction of these reserves and supplies is part of the policy of 'starving' the tanks. The Russians had bitter experience of this in Finland when on more than one occasion their tank formations were destroyed by inferior forces, which, aided by 'General Winter,' were able to cut communications. There are no convenient petrol pumps for tanks in Russia, no food, nothing but fire, sniping from woods or houses, and raids by guerillas so that there is no rest for the advancing troops by day or by night.

The Russians have shown great skill and ingenuity. Their reports abound with instances of individual initiative. Here is a typical example:

> 'At the approaches to the village, the German tanks halted awaiting information from the scouts. But the motor cyclists did not return. They had fallen into a trap prepared for them by our sappers and were captured by soldiers of Lieut. Astavchouk's detachment. The enemy grew worried by the motor cyclists' long absence. He fired several salvoes towards the village. In reply to this Major Svelidov's artillery group opened fire from both flanks. The Fascist tanks moved off aimlessly through the fields, which were fully covered by Soviet artillerymen's fire. Eighteen heavy and eleven light tanks, twelve lorries and seven anti-tank guns of the enemy remained on the battlefield.'

The Russians had a tank force numerically equal to that of the Germans, and they have used them for counter-attacks against the German columns. What one of these battles, in which seven

or eight hundred tanks are engaged, is like was described by a Russian soldier to a correspondent of the *Daily Express*:

> 'It seemed to me as though the world were coming to an end, the noise was so terrific. Houses toppled over. Trees were uprooted and splintered as if struck by lightning. The ground before the battle started was hummocky. By the end it was levelled as flat as a dish pan. Grain fields were chewed until the ground looked as if it had been turned upside down.
>
> 'Germany's tanks were apparently new and in battle for the first time. The opposing machines charged at each other with a roar that deafened me. I could never have imagined it. Before the first impact the tanks spouted a choking cloud of petrol vapour. I had to hold my breath. They jockeyed for position. At the clash of steel against steel the scene for a few moments looked like a motion picture, still where animation is suspended in a grotesque way.
>
> 'But that did not last long either. Some of the tanks that had rammed into each other buckled upward like railway locomotives chashing head-on. Their treads clawed away at the earth trying to get some traction. Many burst into flames. When tanks of equal size smashed into each other the Germans crumbled . . . the battle began in the early morning and continued without a break until the middle of the afternoon. When it was over, the field was covered with upturned smashed and burning tanks. . . .'

It is not a soldier's description, perhaps, but, as graphic a picture of this astonishing new warfare as has been written. To some extent it makes clear the inferno of noise, heat and danger in which the men of the tanks are living.

Alexei Tolstoy gives an account of a tank battle which is more precise and hardly less picturesque:

> 'Our front sector is hushed and waiting. At the exactly planned moment motor cyclist detachments appear rushing headlong and like mad, making a great noise with their automatics. Our snipers . . . pick their targets in the front and tail ends of the column . . . they run into one another, fall, try to détour and perish from bullets. . . . Now the main episode of the battle begins. The Fascist heavy tanks, painted black in order to strike terror, come into action. Then, to take a typical case, they are deliberately permitted to pass over their pontoon

SOVIET ARMY

A modern tank capable of surmounting almost any obstacle

THE NAZI ADVANCE THROUGH BELGIUM 1940

Tanks and armoured units gathered on the banks of the Meuse before the advance on May 14th

bridge. When the bridge is crossed our heavy artillery fire destroys it. The enemy tanks are thus cut off from their infantry; but tanks are a powerful weapon and they proceed to advance. . . . The tank battle begins. None of the participants could give a complete picture of such a battle. Most of all it resembles Inferno. Our heavy tanks counter-attack. Our bombers, flying low, pepper the black tanks with bombs. The latter are also shelled by our artillery. Wherever they get into an infantry zone they are disabled by bundles of hand grenades and fuel bottles. A battle of Olympian gods with giants would look like a football match in comparison with this engagement of steel fortresses.'

Chapter Six

MOTORIZED WARFARE—THE TANK TO-DAY

THE tank has been described as combining the motive power of the agricultural tractor, the armour of the battleship and the fire-power of artillery. It is now made in a number of different forms and is only one of many vehicles used by modern armies. The internal combustion engine, by supplying a faster, more compact and less vulnerable form of motive power than the horse, opened up vast opportunities which were not really fully explored until after the Great War, when armies confronted each other cross hundreds of square miles which had been so tormented by igh explosive or rain that 'open' warfare became impossible.

Mechanization, or 'motorization,' as it is sometimes called, has resulted in each of the three factors which go to make up a tank being used separately and in combination. All three are used in the tank. There are an increasing number of vehicles that have armour and fire-power, but no caterpillars. There are vehicles with caterpillars but no fire-power, like Bren gun carriers or even vehicles which have armour and fire-power but are not self-mobile.

Mechanization has two aspects, strategical and tactical. The strategical part of mechanization is the power given for moving armies rapidly from place to place, regardless of roads or railways. The internal combustion engine combined with the caterpillar have made it possible to move a division, complete with artillery and all the paraphernalia of war, across country at the rate of one hundred miles a day. It does not depend upon armour alone.

Armour, mobility and fire-power produce tactical mechanization exemplified by fighting vehicles from the tank to the Bren carrier. There is a further aspect of mechanization based on the economical factor. Power for power it is cheaper and easier to maintain than horses, which require a vast quantity of fodder.

We have already seen how the tank in Britain developed after the Great War. During this period experiments were going forward in the mechanization of all the various arms of the Army; in 1927 a completely mechanized brigade was formed and put through a series of trials on Salisbury Plain. For the first time there was a force which from tanks to signals was completely mechanized. It consisted of a battalion of forty-eight Vickers tanks, a company of sixteen light tanks, two companies of armoured cars, a mechanized brigade of field artillery, a machine-gun battalion in half-track vehicles, and a mechanized company each of the Royal Engineers with the Royal Signals. Here was the origin of the 'Panzer' division, the self-contained mobile fighting unit that could think of advance, not at the rate of two or three miles a day as in the Great War, but of a hundred miles. The force was named the Experimental Armoured Force, and the experiments it carried out led to the present policy of mechanization in the British Army. The conversion of the cavalry from horses to tanks or armoured cars, they are still numbered in squadrons and troops as in the days of Balaclava, the multiplication of motor vehicles of all kinds for conveying everything from the heaviest guns to machine-gun units and even the foot-slogging infantry.

In 1939 the Royal Armoured Corps was founded, embracing the Tank Corps, which had become the Royal Tank Regiment in the days of peace, together with famous cavalry or yeomanry regiments. In the Great War, tanks were the only vehicles that could reach the front lines and cross them, although once or twice when the tanks had prepared the way armoured cars managed to get through so that the 'bussing' of infantry could be carried out on a small scale. In the new armies, a host of different vehicles may be in the front lines, although there is no 'line' in the old Great War sense.

Tanks demonstrated their usefulness as carriers as well as fighters in 1917, towing sledges carrying supplies and, as mentioned previously, themselves carrying supplies not only for other tanks but also for the infantry. The possibilities of tanks for this purpose have not been well exploited. In the Russo-Finnish war we had Russian tanks towing armoured sledges carry-

ing infantry. The Germans employ tank petrol carriers for refuelling other tanks. There is an obvious limit to the usefulness of the tank for this purpose, for the carrying tank itself has to be re-fuelled and provisioned so that the further it goes the less useful load it can carry, until there comes a time when the useful load approaches zero. But in certain circumstances this combination of strategical and tactical mechanization can be of great value, as the Germans demonstrated in France, and the British in Libya and Abyssinia.

For convenience, tanks to-day can be classified as heavy, medium and light, although no strict categories are generally agreed. The tonnages would be a minimum of twenty-five tons for a heavy, ten tons or more for a medium, and anything below that figure for a light; but these are very rough estimates. Heavy tanks may run up to sixty or seventy tons. The tanks differ not only in size, but in the amount of armour, the nature and number of the guns carried as well as speed. These are decided by the rôle which the tank is expected to adopt. A tank, like a warship, is a compromise between armour, speed and armament. With a given weight available, so much must be allotted to the engine, so much to the guns and so much to the armour. If the armour is to be made thicker, some speed must be sacrificed. If the number of guns or their calibre is to be increased, we may have thinner armour plates or be content with less miles per hour. The size of a tank also affects its range, a heavy tank with a high-powered engine must either sacrifice space and weight to petrol or ammunition storage or reduce its cruising range.

Bearing in mind these facts, let us look at typical tanks of to-day. The heaviest of the heavies seem to be in the service of the Russians, and photographs show some really formidable types with a weight of perhaps seventy tons. France had a number of sixty-ton tanks, but they proved themselves slow. We are not likely to build such tanks, if for no other reason than that many of our bridges would not bear the load, and that their usefulness would be limited in this way. Britain has recently announced that she has a new type of infantry tank in mass production. Its weight is between twenty-five and thirty tons, and it has been announced that for its size it has an unusual speed. The size and weight should give it considerable powers for negotiating rough ground or for crossing obstructions. This tank has been very heavily armoured, no doubt in view of the increased power of anti-tank guns. It is stated that, even if brought to a standstill, it would be

able to continue in action as a very formidable 'pill box.' The armament and other details must, of course, remain secret, but it is known that Mr. Churchill, after whom the tank is named, himself drove one of the first models and was astonished at the manner in which it could be manœuvred—'as easily as a taxicab.' It should be pointed out that because a tank is not turned like a car, but 'skidded,' it can be turned in a very small 'circle.' Watching the manœuvres of the tanks which led them to one victory after another in Libya, led the Australians to christen them 'Waltzing Matildas,' after the popular song they had made their 'battle cry.' These 'Waltzing Matildas' are twenty-six tons, 19 feet long, 8 feet wide, with armour 2½ inches. The speed is low, about 10 m.p.h.

The United States has a very successful twenty-eight ton tank known as the M 3 medium, which she is supplying to Britain. This tank is of unusual appearance, as it has the heavy gun turret at the right-hand side beside the driver's cabin. This limits the angle of fire and makes it impossible for the tank to fire at targets on its left-hand side, but the handicap is not so great as might be supposed. The large calibre gun is reserved for strong objectives. In a second turret in the orthodox position at the top of the tank is another smaller, but still considerable gun, and above this an anti-aircraft gun in a special mounting. The three guns one above the other give the tank a characteristic and formidable appearance.

The United States is also supplying in large numbers the M 3 light cruiser tank, which has already been in battle in Libya. Of this Lord Beaverbrook recently said: "It has proved to be a most valuable weapon. Mechanically, it is the most reliable tank in the world. It was given a severe test of three thousand miles continuous travelling over country of every kind. It stood up to the ordeal magnificently, giving no trouble whatever. It is believed to be as fast as anything in this class the Germans can put into the field."

The function of the heavy tanks is to smash their way through, clearing the way for the lighter tanks and the infantry. Their armour enables them to stand their ground and fight where a lighter tank might probably have to manœuvre or retire. The astonishing punishment these tanks can take is shown by the story of one from Libya which came out of action after receiving over seventy direct hits without being put out of action. British heavy tanks in Belgium showed themselves very well armoured. One

received more than a dozen hits in succession, and a member of the crew afterwards stated that all they noticed was a glow on the armour at the point of contact for an instant; due, of course, to the great heat generated by the bullet striking the steel. The tendency in modern design is, however, to increase still more the armour of heavy tanks and to make the 'freeboard' as low as possible so as to reduce the size of the target offered to the enemy. The speed of this type of tank is generally less than 20 m.p.h., so that it cannot, as with lighter and faster tanks, be relied upon to get the tank out of trouble. These tanks descend directly from the ponderous Mark I of the Great War, but are considerably faster and much better armoured. Not only the thickness of the armour, but its quality has been improved out of all recognition.

The medium, or cruiser tank of about fifteen tons usually has a two- or three-pounder gun and a number of machine-guns. She is faster than the heaviest tanks, not so heavily armoured, but unlikely to be put out of action except by a heavy anti-tank gun hitting at a vulnerable point. A recent British example is the 'Valentine,' formerly known as the Mark III. Some details of this tank, which will be on view in a number of British towns, in connection with the 'Speed the Tanks Campaign,' have been made known. She weighs sixteen tons and carries a crew of three. Her speed is given as 15 m.p.h. In the main turret is a two-pounder and a quick-firing Besa gun. The two-pounder is an anti-tank gun, and has been found capable of piercing any armour yet met on German tanks. The performance of this tank is stated to be particularly good. "They cruise across open country like a car travelling on a good road," says the official report. This is not entirely a matter of the comfort of the crew. A tank that is steady makes possible much better marksmanship than when subjected to bad bouncing and rocketing. The special function of this tank might be to neutralize and destroy the enemy tanks. Another new type in the cruiser class has been christened 'Crusader,' in honour of the work it accomplished in the Middle East. This tank carries a two-pounder gun, mortars and machine-guns. Its armour is given as 'fairly heavy,' but the outstanding point is speed. It is far faster than any tanks opposed to it, and has apparently surprised the Germans.

Finally, we have the light tanks; in this class we may conveniently include the gun carriers and armoured cars. These are not designed, primarily, so much for fighting as for reconnaissance. Their function is to seek the enemy and report his dispositions.

If they encounter opposition, they strike quickly and get away. They perform, essentially, the same functions as light cavalry in the days before machine-guns. They are not heavily armoured, although safe from ordinary machine-gun and rifle fire, and rely upon their speed, which may be up to 50 m.p.h., with a very considerable cruising range. On occasions, they have worked fifty miles or more in front of the main body of the troops.

The true function of the Bren gun carriers is rather different. The guns are not designed for fire from the carrier, although they can be fired, but to be dismounted and fired from the ground. The real object of these carriers is to concentrate fire where it is most needed, and they give the commander a tactical advantage which generals for centuries have sought to attain, the concentration of fire at a selected spot. The carriers can race across the lines to wherever directed, their crews protected against small arms fire, the machines too fast or elusive for artillery, and go into action within a short time wherever directed. It should be pointed out that these vehicles take not only the Bren gun, but also their crews, spare barrels and, no small matter, the ammunition. This is important with automatic guns, which 'eat up' ammunition at such a speed that, normally, several men are employed solely to bring up supplies. The armoured car has been improved out of all recognition in recent years, both in speed and armour, but particularly in the fitting of 'bullet proof' tyres. The tyres are not bullet proof, but self-sealing, like the petrol tank of a fighter aircraft. Solid tyres had formerly to be used and these greatly reduced speed.

The functions of the three classes of tanks are not watertight; however perfectly plans work at manœuvres, there may be considerable confusion on the battlefield. But upon the ability of the light tanks, armoured cars and, in these days, motor-cycle patrols, to find the position of the enemy and communicate it to Divisional Headquarters, now carried in a series of special vehicles which are really offices on wheels, depend the chances of bringing the cruiser tanks into action. It is for the cruisers to seek out anti-tank guns and put them out of action. If the heavy tanks succeed in creating a breach in the enemy's line they can pass through to 'fan out' and create confusion along the lines of communication. Tank battles, in the nature of things, can take an almost endless variety of forms. The mobility of these weapons makes it possible to exploit a local success with a rapidity that was out of the question in the days before mechanization. It is this fact that has led to the, by previous standards, extraordinary

disproportion between prisoners and casualties in recent battles. Mechanized warfare means that victory is likely to be total victory; it is difficult for a beaten enemy to retreat in good order fast enough.

The fundamental difference between an armoured division and a Tank Corps such as Britain built up in the last war lies in the self-sufficiency of the armoured division. The Panzer divisions not only have squadrons of their own aircraft, under the command of the general commanding the division, but lorry-borne infantry, engineers with bridging materials, motorized field artillery and 'clouds' of motor-cyclists, in addition to maintenance vehicles. The striking part of the division are the four hundred tanks of all types, but these must lose their force and power to sustain an advance without their accompanying vehicles.

The German armoured division has a minimum of two thousand five hundred vehicles, including at least four hundred tanks. Its man-power is as great as the whole of the Tank Corps in the Great War. In single column, these vehicles would stretch along twenty-five miles of road. Considerable skill is required to keep a column of this type under control, and extensive use is made of motor-cyclists to maintain communication. The Germans used very many motor-cyclists in Flanders for every purpose, and it is said that six of them took one important town by sheer bluff. The motor-cyclist does not, perhaps, get sufficient credit for the work he does. His duties are dangerous and highly skilled. He must be able to read a map of strange country while travelling fast and combine the skill of a dirt-track rider with considerable powers of observation. At the outset of war, Britain, although she had considerable numbers of motor-cyclists, did not realize their full possibility. Now every officer has to be able to ride, and the great number of skilled riders who had won Britain so many races on road and track in pre-war days will give her a body of motor-cyclists unequalled in Europe.

The armoured column is absolutely self-contained as far as vehicles are concerned. Not least important are the mobile repair shops, which are equipped with lathes and all the tools or machines necessary to repair any vehicle or tank unless it is very seriously damaged. The greatest difficulties are encountered in keeping the vehicles supplied with petrol and, after a period, the men with food. The Germans in France managed to 'live on the country,' satisfying their needs, including petrol, from the villages they passed. The Russians by their scorched-earth policy have made any repeti-

tion of this impossible on their front. This question of supplies is vital, for if there has to be a pause while they are brought up, the momentum of the original attack may be lost. In the Western desert, where not only petrol but also water had to be carried, the British showed remarkable staff work. As suggested when dealing with the future of the tank, aeroplanes may be much more extensively used for supply carrying to tank columns, although a great number would be required to bring the many tons of supplies required each day by a large force.

Until the Russo-German war there had been no occasion on which tanks, in fairly equal numbers, had met, although there had been a number of tank battles. Victory does not always go to the most heavily armoured and armed tank. Although tank battles are often compared with those at sea, the term cruiser is derived from the navy, there is always one fundamental difference. The sea, if we except conditions of bad visibility, offers no hiding place and, other things being equal, victory will usually go to the heaviest ship. This is the principle upon which the British Navy is founded, and is the reason for our large fleet of the heaviest battleships. On land it is quite different. A destroyer would have little chance against a battleship, for it would be blown out of the water before it got within range. Yet by skilful manœuvring and the use of cover, a small tank may knock out a large type; or a handful of tanks, well positioned, may be able to hold off a much larger force of attacking tanks. Tank-versus-tank battles have been so few and the circumstances so varying that the best tactics are still a matter of experiment and theory. We may see some very interesting developments before the end of the war.

The modern tank has altered internally just as it has changed externally. A tank will never be a comfortable place, but the ventilation and disposal of the inevitable fumes has been the subject of many tests, and the atmosphere is now very different from that in which the first men went to fight in tanks. Fans send out the foul air and draw in the fresh. It is believed that the excellence of British tanks, specially prepared in this respect, for work in the tropics, had much to do with our success in Libya, for the better the condition and temperature of the air, the better the crew can fight. The air-conditioned tank is an obvious development.

It took three men to drive the first tanks. This was somewhat complicated, especially as the 'gearsmen' were also supposed to work the guns. In practice, they missed many good opportunities

because they were pre-occupied with their driving. Now it is well established that driving a tank is a whole time job. The driver has a well arranged seat in the front of the tank. Until the time arrives, he keeps his armoured cowl open and has a good view of the country in front. After the cowl is closed, he can see immediately in front of him through a low periscope which reflects into a mirror on his dash-board. He steers the tank by levers, one in each hand. The lever engages the caterpillars when pushed forward, slips in a clutch when brought upright, and brakes if pulled back. It is by putting one caterpillar into neutral and then braking that he turns the tank. Immediately in front of him is a gear lever; the dash carries a number of dials indicating speed, oil, petrol, lighting and other indicators.

In the early tanks noise was such that communication while running was only possible by signs. The various members of the crew of a modern tank cannot see each other, and they communicate by headphones. The commander is in the turret, and his spoken instructions can be heard clearly by the driver. All but the smallest tanks, and even some of these, are equipped with wireless for communication with each other and with headquarters. When near the enemy radio silence may be maintained to avoid giving away the presence and position of the tanks. The wireless operator usually 'doubles' the part of loading the guns. Directions are made easier by the use of large-scale squared maps, on which the course of the tank can be charted very much as the captain of a ship records his movements.

Many of the fittings of the latest tanks are secret, but it can be said that electrically moved turrets are now replacing the hand-operated type, although even these were so well balanced that a slight touch was all that was necessary to swing them round. The difficulty of providing perfect visibility to gunners and commanders will never be solved until someone invents a bullet-proof glass that is as strong as steel. But a very good substitute has been found. The modern vizor is of splinter-proof glass arranged against a 'cushion,' which takes up the shock if it is hit by a bullet. The vizor is a very small target, only a few square inches in area, but it may be hit. The gunner is protected from a second shot following the first by an armoured hood which covers the hole. He is then able in a matter of seconds to insert a spare glass and raise the armoured hood, which is so designed that it cannot be raised from outside, to prevent an adventurous enemy getting at the tank in this way.

Chapter Seven

MAKING THE TANK

IF the unhappy debacle of Crete, the more unfortunate because we had been in occupation for six months, did no more good than convince the higher commands of the need for tanks, it was not wasted. We needed more tanks than had ever been imagined before. Lord Beaverbrook went to the Ministry of Supply, and the public who had followed his good work at the Ministry of Aircraft Production expected the flow of tanks from our factories to be doubled immediately. Perhaps this chapter will indicate some of the great difficulties of manufacturing tanks in large numbers *in a hurry*. The numbers produced will not, of course, be published until the end of the war. Even the number of tanks required by this time next year cannot be made known, but a figure of fifty thousand would be by no means fantastic. The immediate U.S. programme for her own army was an increase from four hundred and sixty tanks to nine thousand two hundred, and fifty thousand other vehicles. There was talk of producing thirty thousand in the Great War when the enemy had none, and tanks were comparatively untried. Fifty thousand tanks in a year would not be beyond the manufacturing capacity of Great Britain and the United States. But how many are produced during the next twelve months will depend, to a large degree, on what has been done in the last twelve months. As in any form of mass production, a great deal of preliminary work must be done before one unit is produced. As soon as the first tank is built, it can quickly be followed by the second and many others at an increasing pace until the maximum output is reached.

In the Great War, tank manufacture was poorly, if at all, organized. Some causes of delay have already been explained, and the formidable list of interested parties or committees which were mentioned, indicate the difficulties that arose even before a design could be approved and an order given for quantities. Various 'boards' or sections eventually merged into the Mechanical Warfare Supply Department under Colonel Stern; this being responsible for design, supply and inspection of the tanks. It was not until 1917, that some sort of final control was given by the appointment of a Tank Committee which satisfied nearly everybody and which was representative of every major interest.

The first tanks were built at the factory of Messrs. Forsters, in Lincoln, who were makers of agricultural implements. When it was decided to build in larger numbers, the Metropolitan Carriage Company, of Birmingham, was given some of the work and, as the programme grew, new factories were brought in. Unfortunately, production never came up to expectations, perhaps because the expectations were too great and took no account of technical difficulties. Indeed, one writer goes so far as to suggest that the forecasts of the output of tanks by the Mechanical Warfare Supply Department were deliberately placed too high to scare reluctant Government Departments and stimulate manufacturers into greater efforts.

The difficulties that arose, apart from troubles in actual factories themselves, centred on priority, policy, or design; perhaps these factors will always appear in connection with the manufacture of a new weapon. Tanks required factory space, enormous quantities of material, and considerable man-power for their manufacture. All three essentials were lacking, were already in demand for a hundred other weapons. In the early part of the Great War, tanks were not high on the priority list. The Ministry of Munitions put shells, guns, aeroplanes and lorries first. This was, of course, partly connected with the second brake on production, that of policy. The various authorities could not make up their minds how important tanks were going to prove. We have seen how orders were cancelled when tanks in the field were a comparative failure and expanded immediately they enjoyed some success. If in September, 1916, it had been said: "This is the weapon that is going to win the war," it is possible that the tanks of 1918 would have been ready a year before and Cambrai might have been a decisive battle. Such a decision, which would have meant 'robbing' other arms, would have been a gamble which it would have been difficult, at the time, to justify. It is always easy to find reasons for a successful venture. Regarding design, one difficulty was that, tanks being still experimental, the tank officers were always finding small improvements that could be made and asking for alterations or delay in the final approval of plans. This is one of the 'bottlenecks' of mass production, of which the danger is seldom grasped by men more accustomed to fighting than to a factory.

The problem of building large numbers of tanks is essentially the same as that of mass producing one type of car. First the design must be agreed and the minimum rate of production decided.

Calculations will then show the factory space required, the machine tools that will have to be assembled, how many workmen must be gathered, and, to a degree, trained. At the same time sources must be found for the raw materials and arrangements made for delivery at specified dates so that the various processes can continue uninterrupted. There will also be a considerable number of 'accessories.' In the case of tanks there are the guns; arrangements must be made for their manufacture and delivery in the correct numbers at the right place on the right day. A car manufacturer might allow two years for all this preparation, two years between the time it is decided to manufacture a million cars of a new type and the moment the first car leaves the assembly line. A tank is a more complicated vehicle involving far larger quantities of material, so that a decision to manufacture ten thousand tanks of a new type is easier taken than put into action. Particularly does this apply in wartime when men and materials are wanted for so many other purposes.

There are definite reasons why it is impossible to increase the production of tanks at a moment's notice. Each of the six thousand odd parts of the tank will be shaped by machine tools, those 'machines that make machines.' The manufacture of these machine tools is a slow and highly skilled process, for to a great extent they have to be hand-made. The reason for this is obvious. The limits of error in the machine tool are very much smaller than those permitted in the part upon which it is going to work. A precision lathe may require to be accurate within 1/10,000th of an inch and the final preparation of its bed may need four or five hundred man-hours of work. A machine tool specially made for one job, such as a gear grinder, may take one thousand hours to adapt. Recently it has been possible to do an increasing amount of work in the making of machine tools with other, even more accurate, machine tools; but these in their turn require very careful preparation. Behind all the machine tools, and there may be thousands in a single large factory, are the gauges which ensure the accuracy of the measurements made; the basis of mass production. These are of special steels, sometimes accurate to 1/500,000th of an inch, and may occupy nearly one year in manufacture. It is a point seldom realized by the layman, but machine tools which make mass production possible cannot themselves be mass produced. They are another 'bottleneck' which, to a large extent, only time can clear.

All this, of course, applies not only to the manufacture of

tanks, but to the manufacture of anything by mass production. The subject has been briefly mentioned to explain why it is not possible for a Minister to say, "Take over that factory and have it turning out a hundred tanks a month by next week." To talk about converting a factory to tank production 'overnight' is nonsense. Even assuming that a factory is well equipped with machine-shop tools, these must be adapted to the work in hand and the workmen must be trained in their new duties. It is not often that existing factories are suitable for the manufacture of tanks, certainly not without extensive alteration. The 'conveyor belt' method by which motor-cars are often mass produced is not applicable to the heavier tank. Twenty or thirty tons cannot be put on a conveyor and passed along an assembly line. Tanks are built more like ships than motor-cars. The various parts are brought to the tank instead of the tank being taken to the components. The vehicle stays on a single spot until its caterpillars and engine have been fitted so that it is able to move under its own power.

A tank factory is really an assembly shop. The parts of a tank, varying in size from armour plates several feet square to rivets weighing ounces, may be brought to the assembly point from fifty different factories. In wartime, there are additional advantages in having a number of factories producing parts because the air-raid risk is spread. But to bring every detail to the point of assembly in the right numbers at the right times require organization; while this matter of machine tools, it must be remembered, applies to each of the workshops producing the different parts. In the case of tanks, the engine may be brought ready assembled, it may have been mass produced on a conveyor since it is a comparatively light unit. Arrangements have to be made to manufacture the correct number of engines with a good margin of spares, for one thousand tanks are useless unless there are at least one thousand engines to fit. In some of the new tank factories, the parts, including the engine, are made and pass in the usual mass production lines to the assembly point.

The result of this need for preparation far ahead is that a tremendous amount of work has to be done over the course of months without any visible return. When tanks begin to come from the factory, they do so at a tremendous rate. A gear may have taken one thousand man-hours to prepare. Why is it worth spending that time? Because the machine, once finished, can turn out a gear wheel once every thirty minutes and can carry on

at this rate until it is worn out. It is not worth using such a method for twelve dozen tanks; it might be quicker and cheaper to build them by hand. For a delivery of one thousand or one hundred thousand it is the only plan that will provide them in months rather than decades. Interchangeability is another vital factor in wartime.

The best illustration of how the plan works came from American tank manufacture during the Great War. America, well-known as a land of 'hustle,' and on her toes after entry to the war, had all the benefit of Allied experience. In August, 1917, she began on two experimental tanks to see how they could be mass produced. Her experts visited Europe. By the end of the year complete drawings and contracts were placed with thirty factories to manufacture the various tank parts. These were to be assembled in three special plants and six thousand tanks of two types built; the orders were eventually increased to twenty-three thousand tanks. It was October, 1918, before the first tank was completed and only one hundred tanks were finished before the Armistice. Yet, and this is the point, all the contracts would have been completed within six months of the first tank being made. This lag is almost inevitable. Unfortunate, perhaps, for normally peaceful countries like Britain and the United States, but it means that eventually, if they give their whole industrial potential to the manufacture of weapons, they can produce in overwhelming numbers with the added advantage that they are up to date.

This explains why Mr. Henry Stimson, in July, was able to say that comparing the production of the previous one hundred days with the one hundred days before that, the production of heavy tanks in the United States had increased by 467 per cent and of small tanks by 475 per cent.

It has been truly said that changes in design held up tank production in the Great War. The man in charge of any mass production is like the editor of a newspaper, he must have a 'deadline' and stick to it; a moment after which time no changes, however improving, can be made. The editor of a morning paper must go to press at a certain hour, however sensational the news coming in may be. The best he can do is to add it briefly in the 'Stop Press.' It is the same with tanks. Take any design and someone will always be able to think of improvement, and when these are added, further examples will occur. If these are heeded, final approval of the designs will be postponed, and postponed yet again, for there is no end to improvement. Meanwhile not only

is the production of tanks held up, but the preparation of the machines to make the tanks, since the modifications which can be made once they are started are limited. 'Good enough' must be the rule, rather than a perfection which is unattainable. It seems a hard saying, but it must be faced. If it were not faced by the leaders of the motor industry, which is as highly competitive as war, no cars would ever be sold.

A tank begins as a series of requirements laid down by the General Staff. They will state the armament it should carry, the number and calibre of the guns; they will probably be particular about the arcs of fire of these guns. They will lay down the armouring required and the speed that is needed. The expert on design will consult with the Director of Artillery and other specialists. Perhaps the manufacturer who is to make the tank will be called. He may be able to point out that certain modifications, without altering the fighting power of the tank, will reduce the man-hours required for building. When the drawings are approved, a 'mock-up' is made. This is virtually a dummy tank, full size, and is produced not so much to get the appearance of the tank as to test out in practice whether it will really take the required number of rounds of ammunition, or whether various accessories such as the wireless, will fit in as comfortably as the drawings suggest. It is possible to test the room available for the crew, the ease with which the guns can be handled and many similar points.

Meanwhile a specimen tank is being constructed. This is the 'real thing,' with an engine and probably a full complement of guns. Its ability to climb, make the required speed and stand up to rough usage is tested; it may be 'driven to destruction' over many thousands of miles of bad going. Particular attention will be paid to its balance. A tank must have a very low centre of gravity so that it will not overturn on the inclines it traverses. At last everyone is, if not satisfied, convinced that it is the best that can be done in the time given and the vast business of preparing factories is begun.

Weeks and months pass. To the outsider it seems that nothing is being done, but, in fact, work is at its hardest period. Co-ordination between a dozen factories has to be ensured, timetables arranged, men trained. At last the moment comes when assembly can be undertaken. A tank 'factory' has to be a vast place with machinery for handling the heavy parts of the tanks, usually by overhead trolleys and cranes. The heavy pieces of armour which

form the bottom, sides, and turret ring, are brought together. Rivets are inserted, not the hot rivets used in shipbuilding yards, but 'cold riveting.' Hot rivets shrink on cooling and there is inevitably a certain weakness at this point. The weakness is of no account with the type of steel used in a ship, but this tank will be subjected to shells and armour-piercing bullets. Cold riveting removes the slightest chance of a weak spot which might start a crack in armour plating.

The turret arrives ready made to be dropped on to the turret ring. The engine is complete, having been tested on a bench, ready to lower and to be fixed in place. The driving wheels and idling wheels with their powerful springs are attached, and the caterpillars, looking like some armoured snake as they lie on the floor, are carried round. Controls and brakes are fixed for testing. At last comes the time when the mechanics have virtually finished. Oil and grease are applied where required, water goes into the radiator, petrol in the tank. A driver takes charge and with a roar from her exhaust the tank clatters out. She is not finished, but passes under her own power to another place for the mounting and testing of guns and wireless. Fifty thousand operations and over six thousand parts have gone to the making of the tank at a cost of £12,000, £15,000 or £20,000, according to whether the tank was cruiser, medium or heavy. Already, before she has started on her trials, the first parts of the next tank are beginning to take shape on the assembly point she has left vacant.

The trials or inspections of the tank are important and severe. Not too severe when we think that the lives of men, the fate of a battle or the fate of nations may depend upon perfection in every part. All the materials—many different types of steel, iron and alloys may be used in a tank—will have been tested to ensure that they are up to specification. Engine, springs, controls, turret, and caterpillars will have been tested before they went to the assembly point. But there must follow practical tests of the assembled whole before the tank is passed for service. It should be noted that these trials are repeated every time the tank is shipped or if it should come out of service for repair. If the testers were not so coldly matter of fact about their business, one would say that they took a sadistic delight in trying to smash up machinery, for it is certain that, except for enemy fire, no tank on the battlefield gets much more severe treatment than on the testing ground. Watching the test, or better still, sitting in the turret of a tank under test, you can wonder how any machine can stand it; when at the end you

GERMAN AMPHIBIANS CROSSING A RIVER

THE ITALIAN ARMY, 1940
Flame-throwing tanks in action

nfully rub your bruises, you may also wonder how men can stand it too.

The first test is, perhaps, a quiet run over fairly even ground. The tester sitting at the controls is all eyes, and ears. Long experience has given him the 'feel' of perfectly adjusted controls; ears can detect unusual sounds over the roar and clatter of the k. He turns the tank this way and that, accelerates suddenly, reverses and periodically makes notes on the form which covers the tank's behaviour. Then follows a 'treat 'em rough' test. The course is arranged to present all the obstacles a tank is likely to meet in the course of its career: pot-holes, a series of one-in-two rises and falls, ditches, brick walls, heavy baulks of timber. The tank is hurled off a slope that sends it 10 feet into the air, crashing down on to its springs. If the springs will stand this, they will stand anything. It is turned suddenly at high speed, by slipping the clutch of one caterpillar and letting the other pull. It is sent through a shallow river, for every tank must be able to cross a certain depth of water without the engine being put out of action. It is driven over boulders or rubble, through sand and then rocketed over a series of 'shell-holes.' It all looks very spectacular, but the whole test has been scientifically devised and the results are most carefully recorded. Then follows a close inspection to see whether any of this rough treatment, a sample of the tank's future daily life, has caused any ill-effect, a final servicing and clean up, when the tank is ready for delivery; 'just one of the hundreds being turned out every week.'

The repair of tanks which have seen service is second in importance only to the manufacture of the new output. In the Great War when every tank was so desperately needed, salvage companies performed extraordinary feats in bringing tanks which had been bellied, knocked out or otherwise put out of action back into the lines for repair. Tanks buried almost to the roof in mud were extracted, repaired and sent back to the scene of action. The general method, if the tank was within the enemy's range, was to go up at night, carrying repair outfits and even spare parts, and work on the tank until it was just running again. If this failed and it was practicable to have the tank towed, it was taken to the central repair workshops behind the lines where many miracles of repair were carried out. On many occasions the good parts from two or three badly damaged were 'cannibalized,' that is taken to build a new tank. Where no salvage was possible any of the smaller parts and fittings of value such as guns or gears would be retrieved. It

was estimated that millions of pounds were saved in this way and, even more important, the number of tanks in the field was kept comparatively high at times when replacements from Britain were coming too slowly.

Maintenance and repair is now even better organized, and large supplies of spares as well as skilled mechanics are sent with every column. Unless a tank is knocked to pieces, completely burned out or falls into the enemy's hands, there is a very good chance of it being made fit for action again. A matter of considerable importance when replacements may have to be brought some thousands of miles from the factories.

A note is more than deserved of the men, and women, who make the tanks. The manufacture of a tank in all its stages requires an army of workers, varying from the highly skilled to those who have been through a rapid course of training under wartime conditions and are able to undertake tasks which require only limited experience. They work alone at machine tools, or in teams varying from two to a dozen in the various processes of assembly. In this duty women have been found particularly good at specific jobs, notably tapping threads where their light touch has led to less breakages than when men are employed. It is easy to think of a tank in terms of so much steel, so many rivets, so much material and so many man-hours, quite forgetting the men and women without whom there would be nothing but a weight of metal. Personal enthusiasm is of immense importance. Lack of it can result in the most carefully planned production falling behind. Keen work, and unforeseen difficulties are overcome; tanks roll out even faster than was calculated.

Major-General Hugh Elles, who commanded the Tank Corps in the Great War, acknowledged the debt of the Corps and the nation to the men and women who made the weapons when he wrote, in 1919:

> "The work carried through in the munitions factories and the ingenuity and solid labour that backed the efforts of the soldier in the field, are, perhaps, not yet fully appreciated by the fighting men. . . . The Tank Corps was fortunate indeed in having established at an early date close relations with its workers, and more fortunate still at a critical time in being able to declare a substantial dividend on the capital of wealth, labour and brains entrusted to it by its section of industrial Britain.
>
> "Once touch was obtained with the worker himself, the

interest taken by J. Bull in the factory in T. Atkins in the field was more than fully proved, not only by the demand for copies of accounts of tank actions, but by the steadily increased output that was maintained. The thing is only natural. Put a man or a woman to turn out bolts from a machine for eight hours a day and you will get a certain result. Tell her or him that the bolts will go into a tank that will fight probably in six weeks time; that the tank will save lives and slay Huns; that yesterday tanks did so-and-so; that last week No. 10,567, made in Birmingham, and commanded by Sergeant Jones of Cardiff, rounded up five machine-guns . . . you will get quite a different result; moreover, it is John Bull's right and due to be told these things."

Lord Beaverbrook established this contact between the men and women who made aeroplanes and the pilots who flew them. We may expect him to do the same with tanks. There is no great space for a discussion of mechanical details; these do not differ vastly from the mechanics of every car in the streets. It is the men and women who make the tanks who are making history at the same time.

Chapter Eight

DEFENCE AGAINST THE TANK

WHEN the Great War ended, very little was known about defence against the tank. The Allies had not, fortunately, had to worry much in this respect, for although the German tanks had shown themselves effective in causing panic amongst unprotected infantry, they had appeared in very small numbers. The Germans, because of early failure, did not take the tank seriously until it was too late. Their defences had never been able to bring tank attacks to a standstill, although they inflicted casualties. At the end, the tank, which was constantly being improved, was definitely 'on top.'

The first attacks took them entirely by surprise and most of their infantry fled or surrendered. A few fired hopelessly at the armoured sides of the tanks, but the only machines 'knocked out' were those which received direct hits from artillery. Field guns remained a weapon in which the Germans put considerable faith for attacking tanks, but, curiously enough, it was not until towards the end of 1917 that they discovered the most effective method: a

flat trajectory at point blank range. An increasing proportion of the forward artillery was assigned to anti-tank defence and as this had to remain 'silent' except in the event of a tank attack on its front, it considerably depleted the fire power. At length, as much as one-third of the artillery was being devoted to anti-tank work.

The ineffectiveness of German defence against the tank was not due so much to lack of ingenuity or weapons as to failure to use them and the fact that the tank itself had a start. Immediately after their first encounter with tanks on the Somme, the Germans devised and manufactured an armour-piercing bullet. This was capable of penetrating the armour of the Mark I tanks and ricochetting inside, where it did considerable damage. The British had foreseen this eventuality; the armour of the 1917 tanks was much improved and proofed against the 'K' bullet. It must have been disheartening to the Germans to find that their new weapon, which was served out at the rate of fifty bullets to every machine-gun, was useless against the Mark IV tanks. They had been encouraged by the failure of tanks in the early months of 1917 and their fears seem to have been somewhat lulled. It is also astonishing that, after many encounters, they seemed to be under the impression that tanks had to keep to the roads. The German authorities put great faith in road pits and in carts of heavy stones used in the roadway.

It was the Battle of Cambrai that gave them a shock and they proceeded on a feverish but rather muddled programme of anti-tank defence. Their commanders had been rather appalled by the psychological effect of tanks on infantry and great efforts were made to counter this by disparagement of tanks. Captured tanks were put on exhibition to show how ineffective they were; pages were written about the terrible experiences of British tank crews who were said to show great reluctance during an advance in the face of opposition, or to fight in a hell of cordite and petrol fumes. The inevitable inaccuracy of fire from a heaving tank was emphasized. Above all, the necessity for the infantry to hold their ground and to keep calm, was stressed.

Germany then produced an anti-tank rifle, a terrific weapon with a kick like the proverbial mule. The German feared his anti-tank rifle more than he feared the tanks and he avoided using it as far as possible. The vast majority of the rifles captured were found not to have been fired. On the range, the weapon proved itself effective; the .53 steel-cored bullet penetrated armour at a good range. The weapon was so ponderous and obvious that,

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whenever used, it was quickly spotted by the tanks and put out of action.

After the Battle of Amiens in August, 1918, the Germans really became conscious of the paramount importance of anti-tank defences, and special officers were assigned to the work in every headquarters. It was too late, however, to hold up the British advance. What would have happened if the war had lasted into 1919 remains a matter of speculation. The Allies would have had enormously powerful tank forces, but the Germans would also have developed anti-tank defences, notably a gun of which six thousand had been ordered at the time of the Armistice. This was known as the 'Tuf,' from the initials of Tank und Flieger, tank and aircraft, against which it was intended to be used. It was a 13-mm. machine-gun with a high velocity bullet capable of penetrating 30 mm. of armour. It would have stopped the Mark IV, but might have failed against the Mark V.

Among other defences developed by the Germans were many forerunners of modern defences, mines, 'teeth,' and ditches. The mines began as buried shells which exploded when a weight pressed on their special fuses and developed into specially made apparatus. These mine-fields were never very effective. Fixed defences also generally failed; the special fascines which were constructed to assist tanks over the great trenches of the Hindenburg line have already been described. On occasions, courageous infantrymen jumped on the tanks and tried to throw in hand grenades or fire weapons through the sight slits. Our tanks were fitted with holed covers through which revolvers could be fired to discourage anyone climbing on the tank. The earliest tanks carried a 'bomb net' to catch grenades thrown on top and roll them to explode harmlessly on the ground. The Germans do not seem to have discovered the effectiveness of fire bombs in attacking tanks at close quarters, although the British tanks were definitely vulnerable to fire.

In the years that followed the peace, every army in the world experimented with anti-tank defences and built or bought anti-tank guns. The Great War ended with the tank 'on top,' but the remarkable change of outlook that took place during the next ten years can be gathered from an attack on British military policy which H. G. Wells made in *The Way the World is Going*, in 1927:

> "Having resisted the tank for twelve years, having muffed the tank outrageously in the war, the British Army is now evidently quite enslaved by the tank," wrote Mr. Wells. "It

> plays with tanks all day and dreams of them at nights. . . . But it is to be hoped for the sake of England and all the world that these exercises will never get beyond the gravity of an expensive amusement for the British military authorities. Because . . . there are scores of ways of countering a tank rush. This tank rush of which the British Army seems to be dreaming now is as out of date as those vast cavalry charges the German Emperor loved to rehearse in 1914. There are pitfalls, there are trailing land-torpedoes, gas-poisoned belts and zones of sudden flame that would make tanks mere cooking pots. A committee of half a dozen alert and intelligent specialists of the type of Mr. Haldane and General Hartley, men who have given their minds to biology, chemistry, mechanics and suchlike sensible pursuits instead of mere soldiering, could work out twenty schemes to make tanks impossible in a month or so. The tank may have been all very well in 1907 or thereabouts; 1914 was the time for it. . . ."

It is only fair to point out that Mr. Wells was arguing that an 'air and gas offensive against vital spots' was the really contemporary form of war, if we must have war, but this extract shows the widely held opinion that the balance of power had changed over to the defences. The wars of the thirties, in so far as tanks were used, seemed to confirm this opinion. When tanks came up against good defences in Spain they were invariably defeated. Even after the Polish war, when Germany practically conquered a nation in a fortnight, there remained plenty of experts to say that this could never happen against positions well defended by anti-tank guns, that the Poles failed because their original dispositions were wrong, or that fighting in the West would be quite different. The spectacular German successes in France and the Balkans, or the British successes in Libya have, perhaps, tended to swing opinion the other way, to give the feeling that nothing can stop a powerful force of tanks. This is an equally unbalanced view.

Modern anti-tank defences can be divided into two kinds: static defences intended to prevent or delay the tank's progress and offensive weapons which are meant to attack or destroy the tank. In actual practice, these two types of weapon are often used in co-operation, the blocking or delaying defences being designed to make the tank vulnerable to offensive weapons.

Tanks have certain definite limitations and blocking devices

take advantage of these weaknesses. A tank can knock over a brick wall, negotiate shell craters, climb inclines of one in two, pass over hedges and ditches, but its caterpillars make it vulnerable to certain types of comparatively small obstruction. 'Asparagus beds,' a series of steel rails embedded firmly in the earth at an angle, usually baffle it, because they offer no grip to the caterpillars. If the tank pushes hard against the rails it will probably be 'bellied,' that is lifted off the ground so that the tracks move round in the air. It was found in the Great War that the broken-off tree stumps which were only too common in the fighting areas were serious obstacles to tanks, which if they ran on to them were 'bellied.' Trees are sometimes deliberately felled to leave a series of stumps to make an effective tank block.

Small cones or pyramids of concrete will stop a tank for much the same reason as the steel rails; there are a number of variations of this type of block which can be used according to circumstances and the materials available. Where it is not desired to block a road until a tank advance is imminent, holes can be prepared, fitted with 'stoppers' to the level of the road surface, and the blocking rails only inserted at the last moment. Concrete is particularly effective in providing tank blocks because its smooth surface offers no grip to the tracks.

There is a limit to the width of trench which a tank can straddle, but this is determined by the steepness of the sides. If the slopes are far removed from the vertical the tank runs down one side and climbs up the other, thus crossing a trench far too wide for it to straddle. To build long and very wide trenches with vertical sides is difficult because of the natural tendency of the sides to fall in as a result of weathering. The modern anti-tank ditch, therefore, has a perpendicular drop on the side from which the tank is expected to approach and a slope upwards on the other side. A tank running into this ditch would topple over the drop and bury its nose on the rising slope so that its tracks would be quite ineffective in moving it forward, merely burying it deeper. To keep the perpendicular face in position it is generally revetted with hurdles or other suitable material. The width and depth of the trench will be determined by the known performance of the tanks it is intended to stop.

Although tanks in the Great War were very effective in tearing up barbed-wire entanglements, it has been found that wire, arranged in spiral form, can be effective in stopping tanks because it becomes entangled in their caterpillars. There may, of course,

be many new types of tank as yet unknown to which ordinary defences offer no bar.

These are the chief man-made devices for blocking tanks. But there are also natural obstacles. The modern tank has a remarkable performance, but it cannot traverse certain types of country. The greatest natural obstacle is water, either 'neat' in the form of dykes, canals and rivers, or mixed with earth in deep mud. Deep marshes are often the most effective of all tank obstacles. These may be made by deliberate inundation; it was this obstacle that prevented German tanks from pushing on to Dunkirk from Calais, it enabled the British Army to embark. Thick forests are an obstruction because tanks cannot pass between the trees, although they are able to push over thickets; moderately spaced trees provide them with very effective cover which enables them to lie in ambush well concealed from aerial observation.

None of these obstacles can stop tanks indefinitely. Major barriers, given time and opportunity, can be skirted, although in preparing defence lines, constructed obstacles are linked up with natural traps; 'asparagus beds' can be arranged between precipitous slopes. But there is no man-made stop which cannot be overcome with ingenuity.[e] In France, the British built a great anti-tank ditch of the type described and arranged anti-tank guns to sweep every yard. The Germans overcame or rather neutralized the defence by 'sacrificing' two tanks which then screened the pioneers from the guns while they blew in the trenches with dynamite. Going back to the last war, we find French tanks crossing the Canal du Nord by deliberately plunging tanks into the great ditch and letting the followers climb over their backs. In the proposed invasion of the Belgian coast, the British overcame the apparently insurmountable obstacle of the 40-foot convex concrete sea wall by devising special ramps which the tanks would carry and climb. German tanks in France carried portable bridges for crossing small rivers and canals.

No doubt as the result of experience in the present war, experts tend to rely less upon these devices for blocking tanks than when mere peace-time manœuvres could be drawn upon for experience. They know that obstacles can be overturned by intense artillery fire or even explosive charges placed by men accompanying the tanks. Barriers would be more effective if they came as a surprise to the enemy; but they need considerable preparation so that aerial photography enables the enemy to examine them in detail and devise means of overcoming them at his leisure. He may, as

did the British in the case of the invasion project already mentioned, build reproductions and practise surmounting the obstructions by whatever method he has decided to use. The main value of obstructions of all kinds for delaying or diverting tanks, remains. Present-day tanks, having the very definite limitations inherent to their design, may well be improved but at the same time some better and more easily erected obstacle may be devised.

Two major objects of tank defence are to drive the tanks into a minefield or to bring them under fire from anti-tank guns. Minefields have become one of the most important of all anti-tank devices and a single field may contain many thousands carefully concealed in the ground. The visibility from a tank is very poor, especially within a few yards and even if the mines are visible, it is impossible for a tank, closed for action, to pick its way. It is not necessary that the mines should contain large explosive charges, quite a small 'bomb' is effective in damaging the caterpillars. Only one of the many plates in the tracks has to be smashed to bring the tank to a standstill or render it unmanageable. The object of a mine is not so much to destroy the tank, but to stop it until it becomes a 'sitting' target for anti-tank guns or artillery. The smaller the mines, so long as they serve their purpose, the better, for the aggregate weight of mines required to cover a small front may run into more than a hundred tons.

A minefield, like other obstructions, cannot stop tanks indefinitely. Artillery fire may be brought to bear on the minefield and explode a sufficient number of mines to clear a 'swept' passage for the tanks. Men can advance on foot in front of the tanks and render the mines harmless, work which is accompanied by great risk, but which has been done on several occasions. Projecting sweeps have also been devised.

The only really effective method of stopping a tank is to destroy it, either by fire, by casualties amongst its crew, or by tearing it to pieces with gunfire or bombs. Anti-tank guns are of many kinds. The field gun, firing with a flat trajectory over 'open sights.' is successful, particularly against the heaviest tanks. Its disadvantages are the difficulty of concealment and the fact that it cannot be swung round very rapidly, so that it can sometimes be outflanked. The task of field artillery with regard to tanks, however, is generally one of defence. The infantry relies for protection on specific anti-tank guns built for the purpose and using special ammunition. There are a wide variety of anti-tank guns with calibres ranging from 1.5 to 2 inches. The largest are carried

on wheels rubber-tyred and capable of being towed by a light lorry, the total weight being about three-quarters of a ton. Guns of this calibre, 1½-2 inches, are worked by a team and have to be hand fed with their ammunition so that their rate of fire is not high. A high rate of fire is as useful with an anti-tank gun as with an A.A. gun. Their shells penetrate armour of 1½-inch thickness and because of their size work considerable destruction. Best known of this type, perhaps, is the Swedish Bofors.

Slightly smaller are the semi-automatic guns with special devices for taking up the recoil so that they do not have to be laid afresh after every shot. The most common in this group is the Swiss Oerlickon with a calibre of .75 inches which fires a 5-ounce bullet and is able to pierce 1¼ inches of armour at 500 yards. It has a very high rate of fire, three hundred rounds a minute, so that a considerable number of shots can be fired at a rapidly moving target before it finds cover.

Smallest of the anti-tank guns are .5 machine-guns firing special armour-piercing bullets. They have a rate of fire up to five hundred rounds a minute and can penetrate at least .5 inches of armour at 500 yards.

Of late, great progress has been made in the design of bullets and shells for use against tanks. The normal armour-piercing bullet has a steel core and relies for its destructive effect upon entering the tank and ricochetting inside. Recent improvements in material and design have reduced to a minimum the chance of a bullet being deflected from the tank's armour. In the ordinary way, if the bullet strikes at anything but an angle of nearly 90 degrees, it is liable to be deflected. Many improvements are still secret.

Very heavy solid bullets may be used by larger guns or they can fire shell which explodes after penetrating the tank's armour. These shells have armour-piercing noses and a fuse with a slight delay action. They may be filled with high explosive or with an incendiary mixture. A direct hit on a vital spot is likely to wreck the mechanism of any normal tank.

Much depends upon the disposition of anti-tank guns; a great deal of thought and experiment has been devoted to this problem. The idea is for the guns to be so placed and concealed that they will be able to strike at the tanks from five hundred to eight hundred yards' range, yet themselves remain hidden. The larger guns are fitted with shields to give their crews some protection, but they are very vulnerable when once spotted. The powerful charge

used causes the guns to give a considerable flash which betrays their position. A further difficulty to-day is the use of aircraft in co-operation with tanks to dive-bomb the anti-aircraft gun positions or indicate them by dropping smoke bombs. Smoke is being increasingly used to screen the advance of tanks. Anti-tank guns may be blinded by a barrage of smoke shells, being unable to see the tanks until it is too late.

Up to to-day anti-tank guns remain the backbone of defence against tanks, and infantry divisions are being more and more heavily equipped in this respect. The Germans, who soon realized the value of tanks, very quickly saw the need for anti-tank guns. Before the war, they allotted seventy-two to a division; about four times the number allowed by the Poles, and twice the number employed by other nations.

More and more aircraft are now being used against tanks. During the battle of France, cannon-firing fighters were tried in a desperate effort to hold up the tanks, and they seem to have enjoyed a certain success. A tank is likely to be more thinly armoured above. The difficulty is that the guns of an aeroplane are often fixed to fire directly ahead so that it is only for a moment at the end of its dive that they can bear on a tank. It is possible that aeroplanes with specially arranged guns may be brought into use for this purpose. Bombs are effective if they hit, but a tank is a very small target. The bombing attack is most likely to be effective where tanks are gathered in large numbers, and the threat of bombing is always useful in forcing tanks to take cover. The tremendous development of air attacks has been shown by almost daily mention in the Russian communiqués during the first month of the battle in White Russia. Recently was announced the award of a D.F.C. to Squadron Leader R. H. Spencer for leading his squadron in successive low-flying attacks against a force of one hundred enemy tanks. The threat to the tank from the air is shown by the mounting of special A.A. machine-guns on large modern tanks.

There remains the attack on tanks at close quarters by infantry. Curiously enough the safest position from which to attack a tank is within a few yards. Its guns cannot be depressed to bear, so that a man very close to a tank is safe from its fire. In Spain and in Finland, infantrymen were exceedingly bold. Many successful attacks were made, notably with fire bombs; these were mostly home-made from a mixture of tar and petrol. The vulnerable part of a tank is its tracks, and a well-aimed bomb may put them out of action. Spaniards and Finns also developed a technique of thrust-

ing a section of railway line or even a crowbar into the caterpillars and thus disabling the drive. Home Guards in Britain have improved upon these devices and have invented several of their own, which will prove an unpleasant surprise for German tanks if they should arrive. This method of attack is essentially one for men with good nerves who are not over-awed, and depends upon taking up a good preliminary position. One remarkable plan of attack developed by the Finns was to dig a small hole by the roadside in which a soldier would wait armed with a half-pound anti-tank grenade. The top of the hole was camouflaged with branches and snow. As the tank reached the hole, the soldier would roll or throw his bomb under the tank. Because of his proximity to the tank, he was safe from its guns. The Spaniards used this method for throwing blankets soaked in petrol into the caterpillars, and the Russians have also shown themselves adepts at this type of fighting, which calls for so much self-confidence and initiative. In combating invasion there is no doubt that a determined people can hold up and destroy tanks in this way, forcing them to go more cautiously and to throw out great numbers of scouts. If these anti-tank methods had been used in France, the Panzer divisions might not have been able to sweep through to the coast so easily.

The adoption of these defensive plans by regular infantry is suggested by the recent news that British troops used 'sticky bombs' against Vichy tanks in Syria. The bombs were described as 'the size of a pineapple,' and were said to stick to the sides of the tanks before exploding with great force. A bomb in actual contact does vastly more damage than when bouncing allows the explosion to operate over an air gap.

One further scheme is difficult to define as a tank, or an anti-tank weapon. Smoke is being increasingly used by tanks to conceal their manœuvres, and most modern tanks carry one or more mortars expressly for firing smoke. This enables them to cover themselves when they come under the fire of an anti-tank gun or to effect surprise. Anti-tank gunners are now also using smoke. An anti-tank gun once seen, and the flash makes it very difficult to conceal once it has been fired, immediately becomes a target for all the enemy tanks. Smoke is therefore employed as cover against tanks. It is a purely defensive measure; it blinds the user as well as the target, but the anti-tank gun enjoys a certain advantage in that after smoke has been used to hide it, it can continue to fire on the tank's predicted course. It has been said that deliberate smoke is the most characteristic feature of a modern tank battlefield which,

in this respect, is not unlike a naval engagement. Smoke is being used more and more to mask all movements or open positions.

Mention must be made of another way in which the tank can be put out of action. It is that of 'starvation.' Tanks must have petrol or they become inert pillboxes and can be effectively dealt with by artillery. Their range without re-fuelling is limited and, generally speaking, the re-fuelling vehicles which follow are more vulnerable than tanks. The Finns disposed of any number of tanks by destroying the lorries carrying fuel supplies. In France, the panic was such that anti-tank precautions of the simplest kind were not taken behind the lines. The German tanks drew up at civilian petrol stations or sent certain units foraging. How easily they might have been stopped was shown in one instance by a handful of our Pioneers who were working with pick and shovel near a petrol station. A German tank drew up to fill, ignoring the men with picks. But these men set about the tank and put it out of action. A pick is a not ineffective weapon when used in the right place. If the Germans had not been over-confident, they would have tried to use their small arms to keep the men off. The principle of defence by denying petrol or food to raiding tanks and by harassing them with every available weapon, remains good. It has been proved to the hilt by the Russians. The mere knowledge that snipers are everywhere forces a tank to remain closed, and this makes conditions over a long period far more trying for the crew as well as seriously limiting their vision during reconnaissance.

There remains the counter of tank against tank. Until the Russo-German war there had been no great tank battles in which the advantages were evenly distributed in regard to quality or numbers of tanks and in air co-operation. Experts will study the results of fighting in which hundreds of tanks have attacked each other, with the greatest care. As an anti-tank weapon, the tank enjoys the great advantage of hitting-power combined with mobility and protection. The tank, indeed, is the logical answer to the tank, and it seems inevitable that this form of conflict will grow until whole fleets of tanks are manœuvring in an attempt to gain a favourable position. Where tanks expect to meet tanks they are equipped with anti-tank guns and armour-piercing bullets, and we may yet see the 'ramming' tank introduced as a new weapon.

The tank has enjoyed such tremendous and, perhaps, unexpected success in war that it may seem bold to suggest a partial defensive domination in the near future. Yet, mathematically, chance seems to favour the defensive, because it is quicker to train

a man to use an anti-tank gun than to train a crew. It is cheaper and quicker to produce a dozen anti-tank guns than a single tank. This is an aspect of the matter which takes for granted that all other circumstances will remain equal. Tank design may not alter greatly for a few months at a time, but the day must come when the most modern weapons we know will be no more than curiosities of the village green.

Chapter Nine

THE MEN OF THE TANKS

TO create a great armoured force means very much more than the manufacturing of a huge number of tanks. The tanks must be manned. A tank crew requires training quite as specialized as that given to a bomber crew; in spite of the contrast between the machines there is a certain similiarity of the subjects in which they must be proficient, such as gunnery, navigation, and wireless. It takes months to make a crew, and if the force is expanding, men must be trained for tanks which will not leave the factories until six or twelve months' time. This implies still more instructors, who themselves must be trained, more training devices and more practice tanks. Altogether, the expansion of a tank force presents as many problems in personnel as in material.

Fortunately, twenty-four years' unbroken tank progress in Britain, the only country with such a background, has resulted in training being systematized. Many devices have been worked out for making it as simple and efficient as possible. Even more important is the continuity of tradition and *esprit de corps*. There are few of the men who fought in 1916, fighting in tanks to-day. But there is an unbroken tradition. The men to-day, with far superior machines, are the descendants of those who so painfully endured the mud and blood of Flanders to the green fields beyond in 1916-18. This counts for a great deal. Candidates for commissions in the Royal Armoured Corps to-day are now encouraged to choose the regiment in which they will serve, either the Royal Armoured Regiment or one of the cavalry regiments which have a record which may go back for two hundred years. It is difficult to think of a greater contrast than that of horses and tanks. It would have been surprising if the change could have been accomplished without some friction, but all the suspicion with which the tank was regarded by the former cavalrymen is now, happily, at an end. No cavalryman ever took a more personal interest in his mount

than does his mechanized brother. Machines are very often given an individual name, and each has a certain individuality. It is a curious fact that, in spite of mass production, no one has ever yet succeeded in making two machines exactly alike.

The first officers recruited for tanks were volunteers from the Royal Fusiliers, who were given no inkling of their new work; they understood that it was in connection with an experimental armoured car unit. They worked with officers in the Motor Machine Gun Corps; the N.C.O.s and men came chiefly from the Sappers. We have seen how they set about to train themselves, a difficult business in the early stages, when no one had even seen the machines they were to use. No one knew what a battle involving tanks would be like. Although they had their imagination and were aided by General Swinton's memorandum, reality showed that the importance of some subjects had been over-emphasized and others which mattered more had been overlooked or neglected. Even at that date it was obvious that tank men would have to be 'all rounders,' as well as specialists in a dozen subjects. There was never, in the course of the war, the time or the facility for the necessary training. The number of tanks never came up to expectations; they were so urgently required at the front that, except during winter 'lulls,' there were very few machines available for training. Canvas tanks carried by men were used at one time for certain demonstrations.

When, during the first winter after the appearance of tanks, men were invited to volunteer, they came from almost every unit of the Army; even from the Royal Flying Corps and Royal Navy. No special uniform was available for them, and those who have recollection of the gathering at Bermicourt will remark on the astonishing sight of men wearing every uniform, from Scottish bonnets to naval blue, working together. Another training ground was set up at Wool, in Dorset, and gradually definite courses were devised in the light of experience thrashed out. However varied may have been the attire of the men when they arrived, they had something in common: a spirit of adventure, the feeling that this was war out of the old rut. It may well be that if any dozen men in the new tank crews of to-day were asked the question: "Why did you choose the tanks?" the majority would reply that they offered adventure, and the others that they were interested in motors or machines.

This spirit was necessary, for a journey in one of the old tanks over the training ground was no joy ride. The tanks jumped and

jolted; those early models had any number of hot pipes or projections ready to catch the unwary. To-day, although riding a tank is anything but comfortable over rough ground, rubber or felt covers sharp edges and insulation guards hot pipes. The men were given two weeks to master driving; to-day we think it good that a driver can be trained in six weeks. They were given a week to learn the machine-gun. The modern gunner to-day gets weeks of training on specially devised ranges. Altogether it takes about many months to make a tank man.

There is a certain glamour which surrounds our armoured columns. In the Great War it was very different. At first they were looked upon with a mildly humorous astonishment, then they were expected to perform miracles. Almost always they felt they were 'on trial,' that if they did not succeed, tank units might be reduced or even abolished altogether. This inspired them to the performance of deeds of extraordinary courage and endurance which have set a standard for tank men ever since. Infantrymen were at first inclined to think the tank crew had sought 'safety' inside their armour, but the crews quickly demonstrated that not 'Safety First' but 'Fear Nought' was their motto. They suffered very heavy casualties, comparable with those of the infantry in the worst of battles, but they saved hundreds of thousands of lives, and this knowledge was an inspiration to the whole corps. It is doubtful whether any body of men have a higher morale. In the nature of things these men had to be individualists, using their own judgment rather than the drill book. Their work was varied and not marked by long spells of standing by in the terrible discomfort of the trenches. Very similar conditions hold good to-day.

A recruit entering the Armoured Corps must have something more than physical fitness to offer, although this is important. He must be in medical category A1 or A2. Fighting a tank calls for physical endurance and, since the efficiency or even the ability to survive, depends upon the weakest member of the crew, risks cannot be taken with men who might crack under the prolonged strain. But the Corps also asks for a good standard of education, intelligence and, above all, initiative or self-reliance. Every recruit is looked upon as a potential officer or N.C.O. Quite recently, one of the regiments of the Royal Armoured Corps was reconstituted as a 'Young Soldiers' Regiment,' for the special purpose of producing the numerous officers and N.C.O.s required. In this regiment, instead of specializing as, for example, driver, or wireless operator, the recruit who is not over 19½ years old has six months' all-round

training before passing to an officer's training unit for four months. Those who do not pass out as officers, may become N.C.O.s, a position of more than usual importance in the R.A.C. where a sergeant or a corporal may command a tank.

The normal tank crew consists of three or four men: commander, one or two gunners, driver and the wireless operator, who also loads the heavy gun. The driver is now usually in a separate compartment. Once the tank has been closed down for action, only the commander sees much of what happens. He has a small visor and a periscope. Driver and gunner rely upon periscopes with limited fields of view; the wireless operator is 'blind.' The commander may be in direct wireless communication with the squadron commander, and he gives his orders through a telephone to the other members of the crew. In his rather cramped turret, he has to be continuously on the alert, studying and marking his map, picking out targets with his glasses or directing his gun. His orders would be something like this: "Driver, advance; speed 12, direction 130 degrees. Gunner, five o'clock, 600 yards, ant." It should be explained here, perhaps, that tank crews use a jargon or slang of their own. An 'ant' is an anti-tank gun. Enemy tanks are always called 'hornets.' A machine-gun is a 'maggie.'

The gunner sits in the turret which, if it is power-operated, he can swing round with a mere touch of his left hand. He is generally seated to the left of his guns, which he fires by a trigger with his right hand. Just behind him is the wireless set. The wireless operator is on his left in a convenient position to feed the two-pounder gun with shells. The positions, of course, may vary with different types of tanks, but this is a typical arrangement.

All these men are, to a degree, specialists, but they are trained so that if one falls out another can take his place. The gunner will be able to manipulate the wireless set or drive in an emergency, the wireless operator to drive or fire the guns. The commander must be a master of driving, gunnery and wireless. It calls for complete confidence between members of the crew and an understanding which can only be gained by practice together. It is not easy for the men to change places in action, but it can be done with a squeeze.

The crews of the earlier tanks were larger. The Mark V tank had a crew of eight men; the commander, usually a subaltern, three drivers, two of whom also manned machine-guns, and three gunners. It has been possible to reduce the number of the crew

without loss of fire power by making the guns able to fire in a complete circle of 360 degrees. In the first tanks, the guns could only bear on targets on their own side of the tank, so that more guns were required. This is an improvement the tank has borrowed from the Navy, although battleships have no turrets able to cover 360 degrees.

The Germans, in their early tanks, made the mistake of carrying far too many men; up to twenty in tanks which were heavier but no larger than British tanks. They even maintained inside the tank the usual army organization, distinguishing between artillery or infantry. It is not surprising that British intelligence officers questioning German prisoners from a tank crew were at first puzzled when the artillery men said it was the fault of the infantry that they were captured, or when the infantry said it would have been all right if the artillery had done their job.

Co-operation is the secret of modern tank actions, the need for it was discovered very early, but it was not until it became possible to fit wireless that it was practicable. Early tanks used pigeons for sending messages back to headquarters. The development of very robust wireless valves able to stand up to vibration made the work of tank commanders far easier. Flags are still used for signalling to infantry. Reconnaissance and planning is still very important. Reconnaissance was vital in the Great War because of the great number of obstacles on the battlefield that could hold up the tanks. The modern tank operates over wider areas and can more easily skirt obstacles, but knowledge of the whereabouts of minefields, or anti-tank guns is invaluable. Before a squadron of tanks go into action there is invariably a conference in which the brigadier or major explains the plans for the attack, and further conferences at which the commanders of the tanks explain matters to their crews.

Every recruit to the tanks first of all receives general training for a short period, and then he begins to specialize. The wireless operator goes to a school where he learns the construction or operation of the instruments he will use and becomes proficient in morse. This is followed by a short course in gunnery with further short courses in driving and maintaining the tank. Altogether it takes many weeks to train a radio operator. The driver takes a few weeks to master the controls, quite unlike those of any other motor vehicle; he also learns something of gunnery, wireless, and map reading. If he is good, he goes on to take a special course in fitting, and he then becomes a driver-mechanic.

Most difficult, and perhaps most interesting, is the training of

a gunner. The gun turret of a tank dashing across country at fifteen miles an hour presents no easy platform for shooting. The target is there and gone in a flash owing to the up and down motion of the tank, quite apart from any change in the target. Gunnery resembles that from an aeroplane, but is even more difficult owing to sudden and unpredictable movements. The gunner first receives detailed instruction in the construction and handling of his guns. He must know every piece of them and become adept at clearing stoppages blindfold; literally. In the big classrooms in which the gunners learn in progressive groups, you may see one of the recruits clearing a stoppage in a machine-gun with a handkerchief tied tightly round his eyes.

Then comes actual instruction in gunnery. This is carried out with the aid of model targets and turrets so fixed that they exactly reproduce the movement of a tank, rolling, yawing, pitching and action, the initials of which give the name 'Rypa' applied to the practice turrets. The gun is synchronized with an air gun and the pellet travels along the same path as a shell or bullet. This makes not only for convenience, but for economy. The pupil proceeds from the first turret in which the motions are slow to a faster type and, when he is proficient, to a model which provides the same platform as that of a tank pitching across broken country at full speed.

The next step is gunnery from the turret of an actual tank placed in the centre of a large training room, on the walls of which is painted a realistic landscape. The instructor names a target on this landscape or throws a spotlight on to it; the pupil has to aim and range his gun, another spotlight showing his accuracy. Finally comes the actual firing on outdoor ranges, no longer presenting great difficulties, since the recruit has been led to it in gentle stages during which it has been possible to show him his faults without the distraction and noise of gunfire. His passing-out test calls for a very high percentage of hits of a variety of targets.

Such is the making of a tank crew. Wherever they are, their work is hard. They may not have the 'foot slogging' of the infantryman, but after every journey there is maintenance on the tank, oiling, greasing, refilling with petrol and water. And, although the inside of a tank is no longer quite the hell of the earliest days, it is still exceedingly noisy. The men learn to let themselves go with the movement of the tank, much as a sailor learns to roll with his ship. They do not suffer the fearful bruises and bumps which are the invariable lot of the 'landlubber' making his first trip in a tank, but a cross-country journey, nevertheless, is a very great strain.

In the Western Desert, the heat, dust, flies and difficulty of getting water added enormously to every difficulty. The devotion of tank crews under trying conditions, quite apart from enemy action, has not yet received full recognition. The astonishing love of a crew for their machine, as great as that of the old cavalryman for his horse, was amazingly illustrated in the case of one tank that gave out in the middle of the desert, far from any possible help. The men worked like Trojans to get it going. Then they found there was no water in the radiator. They did not hesitate. The water from their own bottles went into the radiator, and off they went for many hours without drinking water under the tremendous heat, willing to endure it for the sake of their very own tank. Such an example does not stand alone in the annals of the armoured British Army.

Chapter Ten

THE FUTURE OF THE TANK

WE have traced the tank from its birth as a ponderous armoured tractor, capable of an uncertain four miles an hour over a dozen miles, to the modern tank in its many varieties with speeds exceeding 40 m.p.h. and range of 150 miles. At this time the word 'tank' is to be found on every page of every newspaper, and there is the campaign for more tanks in Britain so strangely reminiscent of 1917 or 1918. There are the tank actions in Libya in which armoured vehicles are carrying out on wheels raids of the same type, with the same purpose, as the infantry so painfully endured on hands and knees in Flanders during the last Great War. Above all, there is the struggle on the western frontier of Russia in which the two largest tank forces in the world are locked in a battle of armour plate and caterpillar tracks.

It would be wrong to suppose that the evolution of the tank has finished. The tank of the future, it is quite logical to imagine, will bear as little resemblance to the tank of to-day as the Mark I to the Valentine or as the first ironclad warship to the *King George V*. The production of new tanks in large numbers involves difficulties which have already been mentioned; the development of the tank during the present war depends upon the lngth of the war and very much upon the nature of strategy determined by both combatants.

Special operations may produce special types of tank It is

generally agreed that, in the present stage of anti-tank defence, any army without tanks is greatly handicapped and cannot maintain the mobility essential to success. The need for tanks has made the invasion of hostile shores a more formidable operation, since it is necessary not only to secure a foothold for infantry and artillery, but also for tanks which, weighing many tons, would be difficult to unload or land in the face of heavy fire. Any infantry landing is likely to be defeated unless a port with facilities for unloading tanks could be captured and held, or unless it were possible to land large numbers of tanks from the air. This consideration, at a time when those engaged can meet only by crossing the sea has given a great impetus to the development of amphibian tanks and, since the extreme difficulty of securing a port is recognized, of methods of transporting tanks so that they could be landed on open beaches.

The production of a tank sufficiently seaworthy to sail twenty miles across the sea is not impossible, but it involves sacrificing to a certain degree the fighting power of the tank once it is ashore. As since its major work is on land, it is usually considered a better proposition to devise a method of transporting the tank by sea; some form of carrier which can be discarded when the tank reaches the shore. The amphibian tank is designed primarily for crossing rivers, a very different thing from actual seaworthiness.

The amphibian has unique value for its own purpose. The alternative method is for infantry, using pontoons, to secure a bridgehead and for the tanks to wait while a bridge is constructed. This involves a temporary sacrifice of the tank's great asset, speed and mobility, and probably that of many lives. No amphibian tank, in the nature of things, can be as efficient as the tank built for land use alone, therefore, I do not anticipate more than a small proportion of any tank force being amphibian, but only sufficient numbers to cross a river and secure and hold a bridgehead so that the bridge-builders can do their work of providing a temporary structure which normal tanks can cross uninterrupted.

But we may expect considerable improvement in the efficiency of amphibian tanks and it is not impossible that we shall see special amphibian brigades. Already, amphibians are becoming reliable, the latest types are no 'freaks' but powerful fighting vehicles. The United States Government recently ordered two hundred amphibians, knows as Roebling Alligators and these may be taken as showing something of the performance which can be expected. Early amphibians were inefficient because they had dual trans-

mission; on land the engine had to drive the caterpillars and in the water they drove a propellor. The Alligator overcomes this disadvantage by turning the caterpillars into paddle wheels. The projections on the links of the track, which are the paddles in the water, are said to be sufficiently small and robust to survive rough going on land. The tank body is constructed of duralumin and is 20 feet long. In the water it is open to the air except for a cabin in front. It carries about twelve men and a total 'cargo' of 7,000 lb. The speeds are given as 10 m.p.h. in the water and 25 m.p.h. on land; climbing qualities are stated to be good.

No details are available concerning this tank which is no doubt excellent for special purposes, but it will be perceived that both speed and armour are sacrificed to performance in the water. The speed of 25 m.p.h. is not high for a tank of this size on land. Duralumin is tough and can be made resistant to salt water corrosion, but while it might stop an ordinary rifle bullet, it would easily be penetrated by an anti-tank gun or perhaps by armour-piercing bullets from ordinary machine-guns. These difficulties will inevitably crop up with amphibian tanks. The type will certainly be developed; it may well become as powerful as the heavy tank of to-day although by this time the ordinary tank may be very much more powerful. The amphibian will always have to pay for its dual function and it is still doubtful whether it will be considered worth other than for river crossings where water speed and 'seaworthiness' are not so important.

To return to the problem of sea crossings, one obvious solution is to use low, flat-bottomed boats to carry the tanks so that they can climb ashore under their own power. The flat-bottom is very necessary to enable the boat to be run ashore. The tank can be carried in such a way that it can climb out over the bows, or the barge may be constructed so that the front can be lowered while the tank is run ashore. Films of the raid on the Lofoten Islands have shown that we have not been idle in the development of what are now generally called 'invasion barges,' for we have barges which are self-propelled and allow small tanks to pass through their bows. The future may produce much more elaborate devices. The whaling industry had built vessels with a very large door at sea level through which whales could be hauled up a ramp to the decks. This suggests possibilities for tank carrying. A small portable bridge might be used to provide the connecting link between the ship and the shore. In theory, a single vessel of this type would be able to carry scores of tanks which would drive from it with

the same ease that an aeroplane takes off from its own carrier. Barges floating nearly awash, or even forming part of the tank itself, would be most difficult to spot.

It is interesting to recall that Britain originated the tank-carrying barge in 1917. The story is well worth recounting if only to show how elaborate are the weapons which may be prepared for a special action and the fact that no obstacle is too much for a tank if it is considered necessary that it should be overcome. In 1917, the German lines began at the sea, south of Ostend, and it was considered that a landing on the coast behind their front could give considerable relief to Ypres. The plan, briefly, was to sweep round and link up with troops under General Rawlinson who held the bridgeheads on the Yser. The idea had been mooted in 1916, but it was not until tanks appeared that it seemed possible for a small force to succeed. The problem, however, was to get the tanks ashore, and, having landed them, how they were to climb the sea wall. This was a formidable 40-foot barrier, constructed in peacetime but constituting an almost perfect tank barrier, slightly concave, and with an overhanging coping at the top.

The British went to work with amazing thoroughness. First the architect who had built the wall was found, a refugee in France. With plans he had brought with him he was able to reconstruct a perfect section of the wall and on this devices for surmounting it were tried. The method finally decided upon was for each tank to carry on a spar in front of it, a ramp which could be lowered by wires. The front of the ramp held two small wheels which could be dropped when required. On reaching the wall the tank was to lower the ramp, run it up the wall on its wheels, drop the wheels and then fix the ramp by driving steel spikes into the wall by the weight of the vehicle. The tank then would climb the ramp over the coping. It was remarkably ingenious, and, after a short practice, the drivers were able to carry out the operation on the reproduced section without a hitch. Incidentally, to preserve secrecy it was generally understood that the rehearsals were for the storming of some forts at Lille. A further device was elaborated for taking lorries up the wall, for if they had been towed by the tanks in the ordinary way their backs would have broken at the critical moment as they swung over the top.

Meanwhile, in England, barges 70 feet long had been built to carry the nine tanks, infantry, lorries, artillery and other material to be used on the expedition. The barges were to be towed by two monitors, shallow draught vessels with powerful armament.

Rehearsals of landing tanks carried out in the Thames estuary were successful.

Everything had reached the point when a date could be set for the attack but, unfortunately, the Germans, perhaps because they had suspected something was 'in the air,' carried out a strong local offensive taking the Yser bridgeheads and destroyed the utility of the operation. The 'hush operation' was, therefore, never carried out and was never heard of at the time by the majority of the public. Perhaps if they had known of it they would have been less trustful of those concrete anti-tank defences in France during 1940.

Certain developments of the tank will follow inevitably from advances in other sciences. The production of diesel engines, for instance, with a higher power for weight ratio will give greater speed or enable the weight of armour to be increased for the same speed. Improved armour will give greater protection for the same weight. The use of new lightweight alloys of great strength in exposed positions will also enable weight to be saved.

Without very serious error, British tanks could be divided into Infantry and Cruiser classes. 'Waltzing Matildas' and 'Valentines' are the large infantry type; their duty is the support of infantry during such operations as the attack of a well-defended position. These tanks are very heavily armoured and can often withstand repeated hits by field or anti-tank guns. Both 'Crusader' and 'Covenanter' are fast 'armour-plated cavalry.' They have the task of harrying an enemy's more lightly defended points, making sorties, or charging a flank. The latest models are streamlined, crews are well protected—anti-tank guns, howitzers and machine-guns are carried.

The question is often asked why huge land battleships are not built immediately. Tanks of one hundred, two hundred, or even three hundred tons, which would be able to carry very thick armour, withstand direct hits by powerful guns and mount the fire-power equivalent of a battery of field guns. There is no technical engineering reason why this could not be done. It is quite commonly believed that the weight of a tank is limited because, after a certain point, the vehicle would sink into the ground or that the 'chassis' would collapse under its own weight. There is no theoretical limit to the size of a tank. The trouble of weight distribution can be overcome; the entire width of the tank could, if necessary, be covered with tracks and, in fact, a four-track tank was invented and constructed some years ago. The larger engines would, if anything,

probably be rather more efficient than those of smaller capacity. The difficulty of the recoil of very large guns is being overcome by new methods of absorbtion. Engineers would, no doubt, be delighted if given the opportunity to design a 300-ton tank.

But other considerations arise, especially with limited manufacturing power. Military authorities might very reasonably argue that ten 20-ton tanks would be more useful than one 200-ton tank, that the chances of all twenty being put out of action or breaking down were considerably less than that of one large tank, however powerful, being knocked out. They would point out that such a tank, because of its very size, would be able to operate only in limited fields and that no bridge would take its load. We have already seen bridges being strengthened to carry the large tanks made to-day. Experts would also argue that a tank of great size would present too large a target. Sixty to seventy tons seems to be the maximum size of tanks used in the present war and it is possible that nothing larger will be used at this juncture. If competition in armaments continues, however, the huge land battleship might be a logical development. It could be protected in the same way as a battleship, by lighter craft, and would carry anti-aircraft defences since such a large target would be vulnerable from above. Even if rendered immobile, such a tank would become a fixed fort and, as such, a considerable obstacle to the enemy's progress. It is possible to present many arguments against the large land battleship, just as it was easy to decry the 35,000-ton battleship. Yet now we find that even 35,000 tons does not represent the limits of battleship construction.

The sea battleship has taken inventions from many branches of engineering and developed them for its own purposes. The tank has not yet utilized many modern ideas. A possible example is the gyroscope. The gyroscope, as is well known, maintains its real position in space regardless of the forces applied to it. It is used in ships to prevent rolling and in battleships to control gunfire. A single track tank could thus be built which would travel like a monorail coach and be able to surmount obstacles with an agility denied to the two-track type. Technical difficulties are considerable in space and weight, for the gyroscope itself must be a high proportion of the total weight of the vehicle in order to establish control. But there might be advantages. The gyroscope could also be utilized to give stability to the gunner. The rolling and jumping of a tank provides a very difficult platform for accurate gunfire. Although the conditions are different, the gyro-

scope might conceivably be used, as in battleships, to overcome this difficulty.

In the last fifteen years wireless has become a standard fitting for tanks. But it has hitherto been used only for signalling. Now, as is well known, wireless can be used for control. An entirely crewless ship can be steered by wireless and its speed governed. An aeroplane fitted with gyroscopic controls can be flown without any pilot and such planes are frequently used for target practice. Even to-day our knowledge of wireless control is sufficient to enable us to send forward a tank without anyone aboard which would obey the orders sent by wireless from an officer far behind and fire its guns as required. One of many serious difficulties is that the controlling officer must be able to see the tank in order to signal. and that, except in unusual circumstances, he might as well be aboard as to be within view. Wireless control could be used for making a crewless supply tank follow a fighting tank. But here again, it may be felt that the additional complication is not compensated by the saving in risk to life. A remarkable possibility is that tanks in the future might be controlled by wireless from aeroplanes flying overhead, opening up a remarkable two dimensional war. This pre-supposes a technical knowledge which, at the moment, we do not possess. It remains a probability of the future. More immediately it is possible that wireless-controlled tanks will be used against special objectives of great difficulty. The crew still remain the most vulnerable part of a tank. The wireless-controlled crewless tank would advance inexorably and nothing short of blowing it completely to pieces would stop it if its mechanism could be protected to a reasonable extent. Wireless-controlled land torpedoes would be an obvious extension of this plan.

We may see the evolution of specialized types of tank. The tank mine-sweeper may be developed to clear minefields on the land as the minesweeper deals with mines at sea. It would explode the mines well in front of it and 'sweep' a channel for those that followed. Similarily we may see a mine-laying tank. The anti-aircraft cruiser at sea may have its comparison on land, especially if attack by aircraft against tanks becomes more formidable. Among other special forms of tank we may see in the future is the burrowing tank, able to 'dig itself in' and take cover, the submarine tank, able to crawl over the bed of a river and cross it without exposing itself to fire, or even the flying tank. As with the amphibian tank, it is better to provide an air carrier for the tank which can be discarded when the moment to alight comes than to

attempt to make the tank itself into a composite aircraft. Indeed, it is doubtful whether the technical problems involved in the latter could be overcome, although we may well see a combination of the tank and the aeroplane. This fighting vehicle might, however, pass obstructions by 'hopping' over them rather than by climbing. The aeroplane would sacrifice climbing ability and speed to heavy armour and armament, the tank would sacrifice armour to speed and the power to jump a hedge rather than to climb. Such a vehicle might be a very formidable weapon of attack on more normal tanks. In the meantime, we may see the development of many 'baby' tanks, utilizing lightweight alloys, which will be bodily carried by aeroplanes. The problems of loading and unloading have largely been solved. The tank which can be carried in sections and easily assembled is yet another evident design.

Co-operation between tanks and aeroplanes has been considerably developed. The Germans brought it to a fine art, the tanks signalling to the aeroplanes when they encountered strong opposition, the aeroplanes warning the tanks of anti-tank guns and clearing the way for the tanks by dive-bombing. In France, this co-operation proved almost irresistible. But co-operation between the two arms has not yet been carried to its logical conclusion. A tank has to worry about communications and the distance from its base only in so far as it must be kept supplied with fuel, food, ammunition and, to a lesser degree, with spare parts. Otherwise it is as independent as a warship on the ocean. The tank must put into port like a warship and, up to the present, it has had to do so at short intervals. But, as General Fuller has pointed out, if tanks can be supplied from the air, "other things being equal, they could hold the field for weeks. Should this become possible then it is obvious that the side which is able to supply its fighting forces the more fully and the more speedily has the advantage. . . . If tanks can be supplied by air, then the whole organization of mechanized forces will have to be modified."

Up to the present no very great imagination has been shown in the armament of tanks. Machine-guns and light guns were available and designers of tanks have mounted them in the best way they could conceive within the limitations of the tank. The addition of quick-firing cannon to the armament of aeroplanes has stimulated research and great progress has been made in devices for taking up recoil. The latest of these remain secret but as long ago as the last war the device of firing a blank cartridge 'back-

wards' to counteract the push forwards was tried. We shall undoubtedly see very much larger weapons added, they will become necessary as the tank itself becomes more heavily armoured. We may see the adoption of new weapons and of automatic turret control. We might have an amphibian tank with a gun which, trained while enclosed within the body of the vehicle, rose up before it, fired and returned hydraulically to its concealed position. The flame thrower has already been mounted on some tanks by the Germans. If gas warfare is to continue, it is logical to fit tanks with gas distributing devices so that by rapid movement they can make large areas untenable or tenable only by troops working in gas masks. A single tank distributing gas by speeding down a road could 'gas' it more effectively than a battery of guns firing gas shells. A necessary counter to this will probably be found by making tanks gas-proof.

Bomb throwing devices may be developed so that they can be worked from the interior of the tank which at present relies upon its machine-guns for attacking infantry at close quarters. Bombs can be thrown, or even driven by rocket principle, into positions which, because of the angle of fire, cannot be reached by machine-gun fire. The possibilities of new ideas in tank tactics were illustrated recently when it was reported that German heavy tanks on the Russian front carried loudspeakers which blared out marching tunes to the following infantry interspersed with orders in code to their officers. The Russians were quick to counter this device. They fitted some of their big tanks with a jamming device to obliterate the instructions.

H. G. Wells, in his story of landships, described previously, mentions a special sight used by the gun crews. This was some form of camera obscura, the gunner seeing the whole countryside on a screen and firing when the target reached a marked point. The photo-electric cell had not been invented in those days, but Mr. Wells may have had some such device as well, perhaps, as television, in mind when he was writing. Photo-electric cells might be used to protect tanks against surprise attack in darkness or smoke. It would be possible to arrange an electrically operated gun which swept any required arc and fired automatically immediately anything entered its zone of fire; distant control for guns is not new. A weakness of the tank is its 'blindness.' It is impossible to provide large apertures for vision because they would immediately become targets for marksmen. It would be simple to suggest a number of ways in which this difficulty will be over-

come, but perhaps the most remarkable will be a development of the television camera or radiolocation. The tank of the far future might have a minute periscope or pinhole apertures and through these, with the aid of devices developed in television, the crew will see on a screen a perfect picture of the countryside. It may become possible, as Mr. Wells suggests, to couple these up with the sights of the guns and make aiming and ranging almost entirely automatic. Television could certainly be employed to send back a view of the action to some base or an underground shelter.

One of the most vulnerable parts of the modern tank is the track; it is obvious that these will receive attention from future inventors and designers. Methods will be found of armouring the tracks and it is even possible that the tank crew of the future may be able to replace damaged tracks in the field. A stationary tank is easy to destroy. So far there have been few developments of methods of rapidly removing a tank that is unable to reach a place of safety. One day we may expect tanks to be equipped with a device for taking other tanks in tow, capable of being fitted without leaving the tank. It may be that electro-magnets will be used for this purpose.

But a few of the possible developments of the tank have been mentioned but they sound formidable enough to a people which, having seen tremendous tank victories, are inclined to overrate this weapon. We must remember that for every improvement which takes place, there must be some new anti-tank defence. Sometimes one and sometimes the other will appear to be supreme; but technical supremacy is always temporary. Offensive and defensive weapons alternate. The tank itself was devised primarily as a defensive weapon against weapons that had made defence so secure, barbed wire and the machine-gun. The day will inevitably come when, for a time, defence against the tank will seem to make the tank obsolete. There were not a few experts who, before the present war, were very inclined to underrate the tank because they knew the power of modern anti-tank defences. What they did not know or appreciate was the number of tanks that were being built and the new tactics which had been evolved. Nor, perhaps, did they grasp the limitations of any static protection. Wherever there have been static defences there has been the possibility of overcoming them, if for no other reason than that the aggressor has been able to discover exactly what has to be done, and then, at his leisure, devise methods of circumventing their strength. Minefields, dragons teeth, walls, trenches and traps of

all kinds have their value, but this is limited compared with mobility, for without mobility it is impossible to have surprise. Modern espionage is such that it is exceedingly difficult to keep a military secret over a number of years.

In the opinion of many the chief defence against the tank to-day is the tank, and this is likely to become more true in future. One might indeed imagine the battle of the future as being wholly between armoured forces. War will follow its age-long pattern, with this difference that the armour will be carried on wheels and tracks. It is still often said that infantry are essential to 'follow up,' that tanks can take, but not hold, a territory. Obviously larger tanks will carry infantry, we have seen this already in the armoured sledges of the Russians which were towed behind tanks to bring infantry to the edge of an enemy's trench.

Until such time as some entirely new weapon is invented, such as a destructive ray, anti-tank defences will remain the same. The bomb, the armour-piercing missile for attacking the tank and various forms of obstruction for bringing it to a standstill or manœuvring it into a required position. The difference will be that these weapons will more and more be carried by tanks themselves. The tank mine-sweeper has been mentioned; we may also have a tank mine-layer, able to act much nearer the enemy than is practicable by infantry alone, and to carry a far heavier load of mines. Many types of automatically controlled travelling bombs are possible; tanks may carry their own folding scout aeroplane or folding armoured motor cycles with front wheel drive. We may have special tanks able to generate high voltage electricity and laying wire which would be virtually a high tension cable. Tank obstacles will be mobile so that it will be difficult for the enemy to ensure by reconnaissance that an area is safe for the advance of their own heavy units. We shall not build static 'pill-boxes,' but have mobile forts which would be able to lower themselves into prepared pits or even into protection pits which they will dig themselves. Travelling speeds may undergo an enormous increase as other improvements are gradually developed.

Tanks have enjoyed spectacular successes in the present war. A few thousand men and a few thousand vehicles have conquered vast territories and destroyed armies of hundreds of thousands of men who were unarmoured, or less heavily armoured. The swing of the pendulum in the opposite direction seems due and we have already seen in Russia that where both sides are equally equipped, the tank is not always so devastating a weapon. Theoretically, a

given number of tanks plus anti-tank guns and other defences should always be able to defeat an equal number of tanks which are advancing. Offensive strategy and tactics have advanced far beyond defensive strategy. The period during which ingenuity in defence equals that in offence, remains to come. That, perhaps, will be followed by a further time in which new tactics will win superiority once more for the attacker. There are no limits to the development of the tank or of anti-tank weapons. It is as absurd to say that 'The tank has had its day' as to believe that 'Nothing can stop the tank' and this will remain true until there is developed another mobile weapon as superior to the tank as is the tank to the chariots of ancient days.

CONCLUSION

IT does seem that the tank, however redoubtable, will not prove a weapon of decisive importance in this war, when both sides have strong defences. This is not to say that armoured vehicles of all kinds will not be used very effectively and will not be used increasingly. I only refer to the tank as a major offensive weapon, and I like to remember Crécy."

"Poland had a million men, not enough tanks and anti-tank guns. France had three million men; not enough tanks and anti-tank guns. Yugoslavia had half a million men, not enough tanks and anti-tank guns. Greece had a quarter of a million men, not enough tanks and anti-tank guns. How do we go in the matter of tanks and anti-tank guns?"

The first quotation is from a writer on tanks in a famous weekly journal in November, 1939, two months after Poland had fallen. The second quotation is from the military correspondent of a famous daily paper in the Spring of 1941. The contrast shows what we have learned about tanks in the Second World War. Or is this too optimistic and are there still people who like to remember Crécy, Agincourt, Blenheim, every battle but the kind of battle we are likely to have to fight to-morrow?

Whatever the limitations of the tank, it is obviously here 'for the duration.' More effective counters to it may be found. Anti-tank guns may take an increasing toll. But this will no more result in the tank vanishing from the battlefield than did infantry disappear when bullets were first invented. The tank will also develop; it is urgent that we should think of it now in numbers, sizes and forms which at present seem fantastic. The limit to the number of tanks employed, should men continue to indulge in warfare, as they undoubtedly will, must be limited only by the manufacturing capacities of the nations concerned. This is logical.

When experts say: "But we shall always need infantry to occupy territories; tanks can conquer but not hold," we should reply that an infantryman with $2\frac{1}{2}$ inches of armour round him or a gun which he does not have to carry can do a great deal more 'occupation' than one with sixty pounds on his back and nothing

but a cloth suit to protect him against the unwelcome attentions of people in the country he is occupying.

No nation has yet had the courage, or the money if that childish restriction is to be maintained, to adopt a wholly armoured army. But it must come as surely as, Crécy not withstanding, the bow gave place to the cannon. Marathon, the Armada, Waterloo, Bunker's Hill and Gettysburg may be excellent memories, but it is sad to deceive ourselves like so many people all over the world during the last twenty years. Memory will not serve us so well as the latest developments of science and engineering. Memory will not help us to overcome the cheeseparing and red tape of certain Civil departments.

In Great Britain, the History of the Tanks is very typical of one phase of our national life. There is no prejudice between the services and, in the face of danger and turmoil, no jealousy in the hearts of the fighting forces. Nor is there the delay or the unending passing of responsibility which is so wrongly criticized by the general public.

Within the last few months, every cavalry regiment of the line has now been mechanized. A few horsed yeomanry remain but these have been reduced in number by conversion to armoured car or light tank units. Immediately after the last Great War no less than thirty-nine Yeomanry Regiments were changed to armoured, technical or infantry. Now, even the 1st Royal Dragoons and the Royal Scots Greys have been mechanized as part of the Royal Armoured Corps.

Freed from unnecessary political or financial restriction, Britain and the whole Empire can have the greatest tank army in the world. We owe it to our men that this should be done, our aim must be that the mobility, protection and fire power of every soldier should be increased a hundredfold. There is no other answer to this demand than by armoured vehicles, tanks of every description and a degree of mechanization higher than any country but our own could ever hope to achieve.

HEWSHOTT: 1941.

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